COMMERCIAL HORTICULTURE IN GREENHOUSE AND NURSERY

R.P. FAULKNER

COMMERCIAL HORTICULTURE IN GREENHOUSE AND NURSERY

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COMMERCIAL HORT
IN
GREENHOUSE AND NURSERY

BY

R. P. FAULKNER

(Head Gardener, University College, Nottingham).

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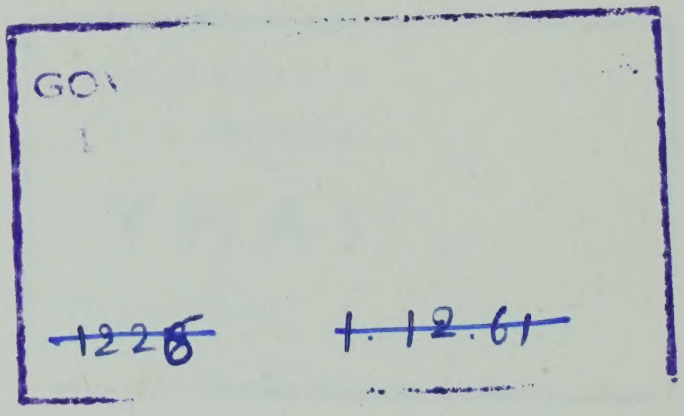

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FOREWORD

This book is intended to be an introduction to glasshouse and nursery technique for those contemplating such work as a career. It cannot be more than that, for no one with however slight a knowledge of the subject will suppose that he can expect to find it fully covered in a book this size. On the other hand, I have tried to make it comprehensive as far as it goes.

It contains no words either of persuasion or dissuasion. It aims to present a true picture painted in sober colours throughout. It leaves all decisions with the reader. If as a result of perusing the book the reader decides that he can make a go of a small general nursery, then I hope the book will be continual help and guide to him. If after reading it he decides that the project is not to be entered into so light-heartedly as he had perhaps thought, then again the book will have served a useful purpose.

Throughout the preparation of the manuscript I have had the benefit of the wide experience, the sage counsel and acute and informed criticism of Mr. Hudson, N.D.H., Head of the Department of Horticulture, Midland Agricultural College. He is here thanked for this and the many other favours I have received at his hands. Thanks are also tendered to Mr. J. Litchfield, Resident Engineer, University College, Nottingham, for help with the chapters on heating, to Mr. Needham, Manager of the Beeston Branch of Messrs. Barclay's Bank, and Mr. Watkins, Accountant at University College, Nottingham, for help with the chapter on Finance. Capt. J. L. H. Chase has kindly contributed the chapter on Cloche Cultivation for Nurserymen.

R. P. Faulkner.

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CHAPTER I

FIRST CONSIDERATIONS

Success in any enterprise in which the results rest entirely on one's own efforts is dependent on two factors: business acumen, and a sound and intimate knowledge of the trade into which one is entering. If an ice-cream vendor makes up a great quantity of ice-cream on a day that promises to be cold and wet, or is found unprepared for the demand of a scorching August Bank holiday, he lacks business acumen. If people shun his ice-cream and prefer to purchase from a rival vendor he lacks knowledge of his trade. Both lead inevitably to failure.

Commercial horticulture is no exception to the general rule. The story of every successful business is one of a demand that was created and supplied with goods and service of a quality that met and overcame competition. No business man would have it otherwise.

At the very outset of this book, then, I would insist that the man who hopes to make good in glasshouse and nursery work must set to work diligently to repair any deficiencies which he feels within himself. Nothing in it can be of any value to the man who has not the flair for business; for making people like him so that they will like dealing with him; for being able to foresee and gauge demand; for buying intelligently and selling profitably; for being cautious and circumspect without being frightened to take a risk; for having the ability to separate the wheat from the tares in the innumerable offers that will pour in on him as soon as he is established; for using money to make

more money; and for acquiring that knowledge and skill of his craft which stamp him as a professional worker in his trade.

The reader may say, " All these are largely matters of experience." So they are; but some learn quickly, others learn slowly. It is the slow learners who are " the hewers of wood and drawers of water ", for their lives simply are not long enough for them to learn the bare essentials to success. By the time they know enough to make a success of a job it is too late; vigour and vitality are gone.

Training

I do not subscribe to the view that only a countryman can make a success of country pursuits, if by the term we mean a man who has lived all his life in the country. Many townsfolk are at heart country folk, and vice versa. The born-and-bred countryman starts with certain advantages, but unless his education has been more liberal than that given at many country schools he has also disadvantages to conquer. The chief of these are the attitude towards scientific progress and the superstitious beliefs, rooted in fallacies, which still affect the thought of the born countryman to a perhaps little appreciated extent.

But what is absolutely essential is that the man who seeks to win his livelihood from the soil and by growing plants must love the soil, and a growing plant must mean more to him than anything else. This is not sentiment. On the contrary, it is the soundest of sense. Some men love engines; they become designers of record-breaking motor-cars or drivers of crack expresses. Some men love chiselling shapes out of stone; they become builders of cathedrals. If your instincts are not offended by the sight of a badly-grown crop; if thistles in a meadow or poppies

in corn mean nothing to you, then keep out of horticulture; it is not your line. If, on the other hand, you feel compelled to get off your cycle to look at a field of well-grown Brussels sprouts, and if the sight of it brings a sense of satisfaction, even if they don't belong to you, then you are, at heart, a gardener: you've got something that belongs to gardening; you are, in spirit, one with the man who grew the Brussels sprouts.

Now, commercial horticulture is a profession that has to be learned. The methods of commercial horticulture differ in many vital points from those of private or public-parks gardening. A training in private gardens or public parks is not of itself sufficient; it needs supplementing. The man with no training at all begins from scratch. The vital fact he must recognize is that he must acquire some training before he can begin to think about setting up on his own. We may say that the man out of a private garden is half-trained, inasmuch as he can handle tools and has a knowledge of the rudiments of commercial horticulture, for the root principles are the same; it is the methods that differ. The man with no training knows only what he has picked up from books and so on, and while that is helpful, it is not nearly sufficient. Men of either of these classes would be foolish to risk their livelihood or sink their capital in a business which they understood as imperfectly as is implied by their lack of training. How shall this training be acquired?

At one time there was no choice. The only way was to enter the employ of a successful nurseryman and keep one's eyes open. Now nearly every University, College, or Farm Institute has its Department of Horticulture where a fair all-round training is given by people qualified both by experience and knowledge to teach. All the indications are that these activities will be greatly extended

and more and more scholarships will be available to the young man who cannot afford the fees.

There is much to be said for a course at a training institution of some kind. They teach the most up-to-date methods. The atmosphere is essentially scientific. Contacts are made which are of the utmost value afterwards. But there are points against them. Two types of students attend them—those who go to *learn*, and those who go to *cram* with the idea of passing some examination to secure a sinecure appointment to which paper qualifications are the *open sesame*. The former are men essentially of strong character; the latter are—well, anything.

In the private nursery the latter are not found; there is no room for them. The young man will come into contact only with young men whose objects are his objects, and he will from the start be absorbing that atmosphere of industry and zeal which is to mark his own career. At many training establishments the students are encouraged —if not required—to spend a goodly proportion of their vacations in selected private nurseries, working with the other workers and seeing other methods. There is everything to recommend this.

But the young man who cannot obtain admission to a training establishment need not be the least discouraged. A period spent at a well-run, up-to-date and prosperous general nursery is very nearly, if not quite, as good. What is important is that he should have a period of suitable training of some kind.

How long should the training last? This will vary. A man who already has a good background of horticultural knowledge may be able to absorb the extra knowledge needed in a year. But the absolute beginner needs at least three years, and preferably longer.

A Wide Range

The range of crops which comes within the scope of commercial horticulture is very wide. It may be said to begin with the cultivation of potatoes on farms of hundreds of acres and end with the production of exotic orchids for the drawing-rooms of Mayfair. But in this book we are thinking more of the small general nursery, where neither the very common vegetables nor the very rare flowers are grown, but where a fairly wide range of subjects is cultivated, all of which have a ready sale to the masses. Strange as it may sound, the large-scale cultivation of potatoes and the production of orchids are largely the province of specialists. In between are many crops which are the legitimate province of the *general* nurseryman.

These crops include tomatoes, cucumbers, winter lettuce, rhubarb, flowers for the cut-flower trade, flowers for wreaths and bouquets, pot plants, bedding plants, perennial plants for the flower border, vegetable plants for the amateur's garden, and so on. In addition, the nurseryman may act as retailer for all kinds of horticultural sundries, and the margin of profit on some of these is very attractive. He may also sell fruit trees and ornamental shrubs purchased from a wholesaler at the beginning of the planting season.

It will be seen from the above that there need be no off-times; on the contrary, money can and should be coming in all the year round. This is of importance to the beginner whose working capital may be limited.

In the larger nurseries a certain amount of specialization is practised. This leads to economies in production expenses. But many large specializing nurseries started as small general nurseries: specialization came only when

progress and finances justified it. In some nurseries a certain amount of stock-keeping—mainly pigs—is practised. These are fed on the vegetable waste, and in return produce manure. In some cases the procedure may pay, but by and large I do not recommend it. There is a grave danger that the nursery may be neglected for the stock or vice versa, and vegetable waste can be turned into compost quite as good as animal manure; indeed, better than pig manure, which is quite unsuitable for many horticultural crops. If time and labour and locked-up capital are taken into account I doubt if stock on a small nursery is really worth while. The case of the smallholder with whom stock-keeping provides a considerable part of his income is quite different. He is not, and does not pretend to be, a nurseryman.

The "Partner"

Before concluding this preliminary survey I want to write something on a subject which I approach with the greatest diffidence, yet which I think ought not to be left out. The subject is, Of what help can a wife be to our budding nurseryman? He may not be married or have any intention of becoming married. But I think he probably is. By some strange but profoundly wise dispensation of Providence, the ambition and restlessness which mark the man "anxious to get on" are often associated with early marriage. His enterprise will probably be a joint partnership. What is the place of the "junior" partner?

A good wife can make success assured if the husband possesses the necessary qualities; a bad wife can make success wellnigh impossible. Some women have a good business instinct, particularly in attention to details. The wife will—or should—know what appeals to women,

and inasmuch as possibly 75 per cent. of the nurseryman's customers are women, this is of obvious importance. But I think the settlement of broad general policy should be the man's responsibility. I venture to say that the vision and capacity to look far ahead are practically a prerogative of the man. I say this in no disparagement of women; they have compensating qualities equally important. But most women are inclined to be over-cautious in matters of business.

The first responsibility of the wife is to see that her husband is well fed! Health of mind and of body are largely the products of wise and adequate feeding. Then his home should be peaceful, so that the atmosphere essential for thought and reflection is not dimmed, or deep concentration made impossible, by disturbances which the wife can and should prevent. Then she should be a good mixer with other women, for by knowing her they will come to know her husband and bring trade to him in many ways.

How much help she gives with the actual work on the nursery will depend on her physical strength and household ties. She should help all she can, in the first years at any rate, for this has a psychological as well as a practical value. Lastly there is the help she gives not as a partner in the business, but as a wife. It will be unique amongst businesses if there are not times of worry and anxiety, if the wolf does not sometimes draw very near the door. At such times the good wife shows herself, and the bad wife becomes stripped of the veil of dissemblement with which she may have covered herself. The good wife, by knowing when to speak and when to remain silent, by knowing what to do and what not to do, and by feeling hopeful and courageous, so radiating hope and courage, may pull the business through. The bad wife may give it the last little push needed to send it hurtling into the abyss.

CHAPTER II

SELECTING A NURSERY

We will now assume that the budding nurseryman has completed his period of training and is looking round for a suitable site for his nursery. Two choices present themselves: he may either buy or rent a small nursery already established, such as are advertised from time to time in the trade papers, or he may acquire a piece of land and, as it were, build up his nursery from the beginning himself.

There are points in favour of both methods. If a start is made with an established nursery, then a fair income should be earned from the beginning, but of course far more capital will be needed to purchase the property and goodwill. Even if half the purchase price is raised on a mortgage it will still leave anything up to several thousand pounds to be provided by the purchaser, according to the extent of the property, its position and the value of the buildings on it. Moreover, money paid for goodwill is largely money locked away, inasmuch as when the goodwill again comes to be sold it may be found not to have appreciated much in value.

I cannot find it in my heart to recommend the renting of a nursery, even if on the face of it the proposition seems attractive. For one thing, the inevitable recurrence of rent day is a millstone round the business, very often taking the cream off the profits, and continually draining the banking account of money sorely needed for improvements. Moreover, I think that from the psychological as

Smallholder

Maintenance work and the fairly heavy costs of upkeep generally do not warrant renting a nursery. By buying, or leasing for a period of years, one is able to get an adequate return for these costs.

Smallholder

A popular form of glasshouse heating is the small boiler, from which pipes carry a circulation of hot water. Such boilers may be fired with coke, coal or anthracite.

well as strictly material viewpoint the nurseryman should *own* his land, so that the urge to improve the general value of the property and the fertility of the soil by long-term manurial programmes is not dulled by the feeling that it is not his own property that he is improving.

In fairness, however, it must be said that a succeeding tenant may be compelled to reimburse him for some of his outlay. Nevertheless, I say, "Own your land yourself, even if it means a great initial sacrifice."

Buying an Established Nursery

The purchase of an established nursery requires the strictest investigation. There are many factors to be borne in mind. The first step will be to consider whether the property is of the right size and whether the general site and lay-out are propitious for success. There is little danger of the beginner taking a place too large, but there may be a distinct danger of him taking a place which offers limited scope for expansion.

The site is of importance. A place on a busy main road which offers chances of free advertisement and roadside sales is obviously worth more than one remote from the passage of traffic and people. Proximity to a populous residential district offers scope for abundant profitable trade. Nearness to a town will reduce cartage and rail expenses on produce as well as providing a market to be exploited by the man who knows how to make money. Attention to these and cognate factors may make all the difference between success and failure, so do not be in a hurry over the initial selection, but look at several and try to visualize them as your property, and ask yourself, "Is this the place for me; can I make a living here?"

Also consider whether the locality is propitious for a ready sale of wares or is subject to waves of depression

which may bring the business down just when getting nicely going. Consider also why the present owner is leaving, whether he and the place look prosperous or there is an air of failure about them. These and other questions will occur to the buyer who is on his toes. The County Horticultural Officers will help with doubtful points.

Having decided on a suitable nursery, the next step will be to have it valued and inspected by a qualified valuer and the title-deeds scrutinized. The property may carry ground rent or tithe charges, or there may be reservations protecting the rights of adjacent property-owners. All these need careful investigation. The local bye-laws devised to " protect " the amenities of the district may be a source of trouble at some future date.

It is necessary for the intending purchaser to find out if he is likely to be prevented from doing anything he may wish to do, such as opening a small sales shop by the roadside.

The actual negotiations will be conducted by the solicitors of the respective parties to the sale, and the buyer should know who is to pay the fees and stamp duties and so on, associated with the transfer of the property.

Renting or Leasing

As stated above, I am not generally in favour of renting a nursery on a short-term tenancy—that is, on a year-to-year basis. Such a position is altogether too insecure to be considered satisfactory. The essence of a business is its permanence, which means its location in one place so that a name and value of goodwill are built up round it—this name and goodwill eventually forming a by no means insignificant item on the assets side of the balance sheet.

Leasing a property is, however, a somewhat different matter, for under the terms of a lease the occupier knows

exactly how long he is to enjoy uninterrupted occupancy of the property; it may be for ten years, twenty-one years or any other number of years. Knowing the length of the lease, the lessee may lay his plans accordingly, and he will not spend money in creating values of which he is not to reap the reward.

Leasing a property is obviously a better proposition than renting it, but it still is not so good as owning it, where all benefits of appreciated value, goodwill and the rest, accrue to the one who has created them.

Much of what was said regarding purchasing a nursery is applicable to leasing one. Site, locality, suitability and general condition of buildings are obviously important. The history of the nursery should be known—whether it has a good record of successful trading. Expenses of upkeep must be carefully estimated, for it must be remembered that the lessee is usually responsible for repairs to the property, and the lease will probably contain a clause requiring the lessee to leave the property in the same condition in which he found it. In this connection it must be remembered that glasshouses are perhaps the most expensive of all kinds of buildings to keep in good condition, and neglect hastens serious dilapidation to an extent greater than with most buildings.

The general efficiency of the heating system for the glasshouses must be inquired into—whether it is adequate for the crops to be grown. Finally, before signing the lease the property should be reported upon by qualified people acting for the prospective lessee. There will be a valuer to assess the terms of the lease; an architect to report on the general condition of the buildings and a boiler inspector to report on the condition of the heating apparatus. Money spent thus is wisely spent; the prospective lessee will be showing that he is a business man,

and business men don't enter upon projects until every relevant detail has been scrutinized and weighed in the balance.

Before leaving this aspect of our subject I would utter a warning against taking as nurseries gardens formerly attached to private establishments. The terms offered by owners anxious to get these encumbrances off their hands may appear attractive on the surface. But in nine cases out of ten such gardens are utterly unsuitable for running on commercial lines. The glasshouses are not constructed for economical working, as are commercial glasshouses. Often the heating systems are uneconomical and badly designed. The soil is usually disease- and weed-ridden—the inevitable concomitant of the progressive neglect that brought such gardens into the market. Usually they are inaccessible and remote from good markets. It is impossible to create round them that air of prosperity which of itself attracts custom. On the contrary, the atmosphere is usually of the same decay that marks the mansion and its owners—an atmosphere of a day that is done, of an age that is dead, and certainly not that of a young and virile future. The fleeting prosperity such pseudo-nurseries may have enjoyed through the war years should not blind anyone to the inherent unsuitability of most of them to meet the intense competition of normal times.

Starting a New Nursery

We now come to what is, in my view, the most attractive proposition of all for the beginner—that of building up a business right from the beginning. The advantages—and to my mind they are great advantages—are: (1) that the maker of the business will—or should—reap *all* the rewards for *all* the values he, by his industry, acumen, and good

fortune, creates; (2) that he will be able to plan the nursery for his particular business; and (3) that he will be able to take every advantage of modern developments in nursery technique.

It is essential that the land be either purchased or taken on a long-term lease. The former is, of course, to be preferred. In no circumstances should renting on a yearly tenancy basis be considered unless the renter is fully prepared to have his land taken from him as it is entering its most productive phase.

The remarks as to site and locality noted in connection with purchasing or leasing an established nursery apply with equal force in establishing a new nursery. In addition, there are factors peculiar to the latter to be considered. The first of these is the inherent fertility of the soil. A friend of mine who, from the smallest possible beginnings, now farms upwards of 500 acres of highly fertile land once said to me that there is some land too dear if it were to be had for nothing. The assertion is profoundly true. What he meant was that the expense of making and keeping it fertile absorbed all the profit. Both literally and figuratively land can be "hungry": hungry of labour and manures—and profits. Better by far to pay a good price for good land than a low price for poor land which is dear at any price.

The best type of soil for nursery work is a deep light to medium loam—a soil that can be worked nearly all the year round, which warms up quickly in spring and on which plants make good root-systems and over-winter well. Thin soils must be avoided, as must heavy clay soils. If the site is old arable land, have the soil tested for club-root and other root fungi, which are not so easily eradicated as might—in some quarters—be supposed, and whose presence may preclude for some time the cultiva-

tion of several profitable sidelines, such as brassica plants, wallflowers and other members of the Cruciferæ. The soil test should also include the reaction for acidity or alkalinity. If the analyst reports the reaction to be anywhere between pH 6·0 and 6·5 it may be taken that the land is suitable for most horticultural plants without any radical treatment. If the reaction is pH 7·5 or over, it means that the soil is too alkaline for very many horticultural plants and excessive alkalinity is not easy to correct. If the pH is lower than 6·0, it means that the soil is markedly acid. This will suit some plants, such as heaths, rhododendrons, lily species; but there are many plants that it will not suit, and these include such important crops as lettuce, chrysanthemums, the brassica tribe, and many others. Acidity can, however, be reduced in time by liming.

The pH values given above are for average conditions. The effects of acidity and alkalinity are, however, accentuated by drought, and plants will tolerate a degree of acidity or alkalinity on a moist soil which would be lethal on a dry soil. Old pasture-land is sometimes very acid, and is often highly infected with root fungi of various kinds, including " finger-and-toe ". The Government's liming policy has reduced the extent of land of this description in recent years, and one has now a far better chance of finding a soil suitable for general horticultural crops than was the case, say, thirty years ago.

Needless to say, the site must be well drained by natural flow to the subsoil. The water-table at its winter level should be 3 ft. or more below the surface, or endless trouble will be experienced with root-rot of plants, not to mention the settlement of foundations of buildings. If the site is being examined in summer, a high winter level of the water-table may often be ascertained by studying the

cores taken out by the boring tool; if within 3 ft. of the surface a thin layer of differently coloured soil appears, this probably indicates the height of the winter water-table level, and the land should be regarded with suspicion. If further investigation confirms the suspicion, it should be rejected.

The Land Needed

Whilst the soil is being considered, the general lay-out of the site should receive close consideration. The plot may be a parcel of land of which the purchaser has to take the whole or none. If so, its area is of vital importance. I do not think it possible to establish a mixed nursery on less than half an acre of land if it is to provide a good living, and I think 1 acre should be considered the minimum. A site of from 2 to 5 acres is an attractive proposition, for this gives sufficient scope for expansion to satisfy the most ambitious without locking up too much capital. The land not required for immediate intensive development may be either left in grass and the grazing let off, or cropped with some easily grown and remunerative crop, such as peas, summer cauliflower or Brussels sprouts.

A square or rectangular shape is most convenient. Any shape approaching triangular is less to be desired as leading to difficulties in planning the economical heating of houses from a central boiler installation, as well as making for waste of ground space.

A level or slightly sloping site will be most convenient for building on and working; no objections can be raised to a gentle slope to the south or west, but a northern slope should be avoided, as should a site sloping steeply in any direction.

An adequate water supply at all times is of vital im-

portance, and if there is no water on the site, make sure that a supply which will not fail in times of drought can be obtained from the local water company. Avoid localities called " frost-pockets " noted for late spring and early autumn frosts, also proximity to factories which pollute the air with sulphur and dust-laden fumes, both of which are highly inimical to plant growth.

A site near a river where morning mists linger long after they have cleared from the higher ground is undesirable as being colder, so calling for more fire-heat, and darker, especially in the short days of winter, when every minute of real daylight counts, and is reflected in the growth of the plants.

CHAPTER III

PLAN OF A NURSERY

THE purchaser of an established nursery buys a property that is already developed to the stage of providing an income. He may develop the property and extend it or within limits modify its plan, but the original plan will be the nucleus of all future developments. He can only add further stories on to a foundation already laid. If the original lay-out was bad its badness will be always there; if it was good the new owner reaps the benefit of another's thought and foresight.

If an entirely undeveloped site has been acquired the success of its lay-out rests entirely with the planner, and it behoves him to see that no thought or care is spared in this most important matter.

We are assuming throughout this book that the reader is interested mainly in a general nursery, and not one that specializes in two or, at most, three crops, as do many of the larger nurseries. I think this far and away the best policy for the newcomer to the trade. Specialization brings larger profits, *but only to the specialist.* The beginner had best learn to walk before he tries to run. Specialization implies wide experience and a capacity to gauge the market, if ruinous glut prices are not to take the gilt off the gingerbread.

The fact that the nursery is to be a general nursery will obviously affect its lay-out. On page 32 is the ground plan of a nursery which is the flourishing property of one of my friends. It will serve as an illustration to examine and analyse.

In the Houses

The foundation of the scheme is one large growing-house, 140 ft. by 30 ft., divided by a cross-partition into two houses, one of which is 90 ft. by 30 ft. and the other 50 ft. by 30 ft. The house marked "A" is used for first-crop tomatoes, late chrysanthemums, sweet peas and lettuce. That marked "B" is used for raising tomato plants for spring sale, and afterwards partly filled with tomatoes for late picking.

This house has a certain amount of permanent staging on which ferns, foliage plants and plants for sale in pots are grown. It is also used as a propagating house for raising bedding plants in spring. It is regarded to some extent as a show house, and the small sales shop communicates directly with it, so that visitors to the shop may see into it through the glass partition, and may be conducted round it.

At Christmas the side staging is lit up with the beautiful shades of primula *sinensis* and p. *stellata* brought on in the forcing-house, and on the centre stage solanum *capsicastrum*, narcissus Soleil d'Or, pteris *major* and asparagus *plumosus* tempt the purse of the visitor. The vendor is wise in that he can meet all purses; he can offer a primula *sinensis* seedling in a 60 pot at one shilling, or a small bowl of narcissii for which he can ask half a guinea—and get it. He is a business man in that he does not despise the customer of limited means, but at the same time caters for the more affluent. In a word, he casts his net wide and catches fish of all sizes.

Similarly at Easter narcissii of the poeticus group, for which people willingly pay a little extra for their perfume and the purity of their flowers appropriate to the season and its associations, are set against the vivid hues of the

cinerarias. The contents of this house always reflect the keen sense of widely differing public tastes which the nurseryman possesses.

These two houses and the shop are heated from boilers contained in a roomy boiler-house adjacent to house A. A bunker holding 5 tons of fuel is separated from the boiler-house by a low partition wall. The bunker is filled through a manhole placed conveniently to the service road.

By the side of the large house is a span-roof house 140 ft. long by 14 ft. wide, used for general propagating, for forcing winter flowers and for cucumbers in summer. This also is divided by a partition into two houses and is heated by the main boiler.

At the rear come the Dutch houses, at present unheated and used mainly for maincrop tomatoes and November chrysanthemums. Eventually these are to be heated, so increasing their usefulness.

Parallel with the main greenhouses are the Dutch frames, used for producing lettuce, radishes, "spring" onions, bedding plants, and vegetable plants for spring sale. These are at present unheated, but the owner plans to have at least one row heated by buried electric cable when supplies become available.

The rest of the cultivated ground is given over mainly to outdoor chrysanthemums, chrysanthemums for lifting, autumn-sown annuals for the May and June flower trade, spring bulbs for wreath work, seed-beds of brassica plants, autumn bedding plants and the nursery bed for the rhubarb.

The Shop Part

The small shop leads straight off the main road. In it a goodly assortment of flowers and vegetables in season,

ready bunched for sale, is found, together with packeted artificial manures, insecticides, seeds and a selection of the less costly sundries, such as syringes, bamboo canes, twine and raffia, trowels, hand-forks and so on.

Between the shop and the service road is a small show-ground, where may be inspected samples of rock-garden stone and crazy paving from a quarry in the district for which the nurseryman acts as agent. Also garden ornaments and seats gladly supplied by the makers on a sale-or-return basis.

The ancillary buildings consist of a compost-mixing shed, in which is a soil-sterilizer of the "John Innes" type, a packing-shed and a shed for stores, tools and the trailer for the car. These are all on the east boundary of the property, and are substantial buildings of wood and asbestos. On the wall of the forcing-house, and protected by a roof of matchboarding and felt, are racks for pots and boxes.

This nursery, like Rome, was not built in a day. On the contrary, it is the result of twelve years' hard work, and it is not yet finished. But the important thing is that the plan for the whole was drawn up before the first building was erected, so that as buildings are added they naturally fall into place and fit in with the rest of the scheme. One or two points in the scheme may be of interest before we pass on to a more detailed examination of individual units in it.

First it will be noted that the greenhouses are clustered round the boiler-house, so that heat is not wasted in service pipes. This is important, for fuel is one of the heaviest "overheads", and anything that will make for the maximum conversion of fuel burnt into effective heat is worth while. The houses needing most heat are nearest the boiler. The boiler-house is large enough to accommo-

date boilers of sufficient capacity for the complete scheme and also an electric circulation pump, which will be desirable when the Dutch houses are added to the load. Without anticipating the subject-matter of a later chapter, we may note here that two medium boilers are more economical than one large boiler. Not only is better regulation of temperature obtained, but the dual installation is a measure of insurance against breakdown at a critical time.

Then we note that the two main houses are presented end-on to the road, where they catch the eye of passers-by, and if the motorist speeds by on most occasions, we may presume that the location of those houses is registered in his memory, and some day when his wife has asked him to bring back a pound of country tomatoes or has reminded him that " it's time the wallflowers were in ", he may recall those two greenhouses and stay his hurried course outside them.

The Dutch frames running parallel with the main houses are handily placed for serving customers with their various contents—far more so than if they had been placed at the rear. If and when necessary, more rows can be added up to the west boundary. At present this ground, with the ground intervening between them and the road frontage, is given over to flowers.

The nursery ground, whilst not very large, yields a great quantity of produce by careful planning. On the north boundary is the rhubarb bed, where the crowns are built up to forcing size.

The servicing arrangements comprise a hard road leading off the main road, by which fuel is brought by lorry and tipped straight into the bunker. Loam, manure and so on also come in this way, and space is left between the various buildings for a horse and cart or a small lorry

to reach the greenhouse doors and also the nursery ground and Dutch frame. Thus time-wasting moving of bulky materials in wheelbarrows is avoided.

The Outbuildings

The first of the outbuildings is a large, open-fronted shed with a concrete floor. This houses the "John Innes" type soil sterilizer, and there is plenty of space for mixing the quantities of compost needed for potting, seed and pricking-out boxes and the rest. Next comes a closed shed well lit by large windows in the front and by skylights. This is used for a variety of purposes, such as making up holly wreaths at Christmas time, when extra hands are engaged for this work, bunching narcissi at Easter, packing tomatoes in June and July, and so on. Next comes a large open shed under which fertilizers, bales of peat, and the like, are stored and the trailer for the car and the rubber-tyred nursery truck are kept.

The owner has no need for a garage at the nursery for his car, as this is garaged at his private house.

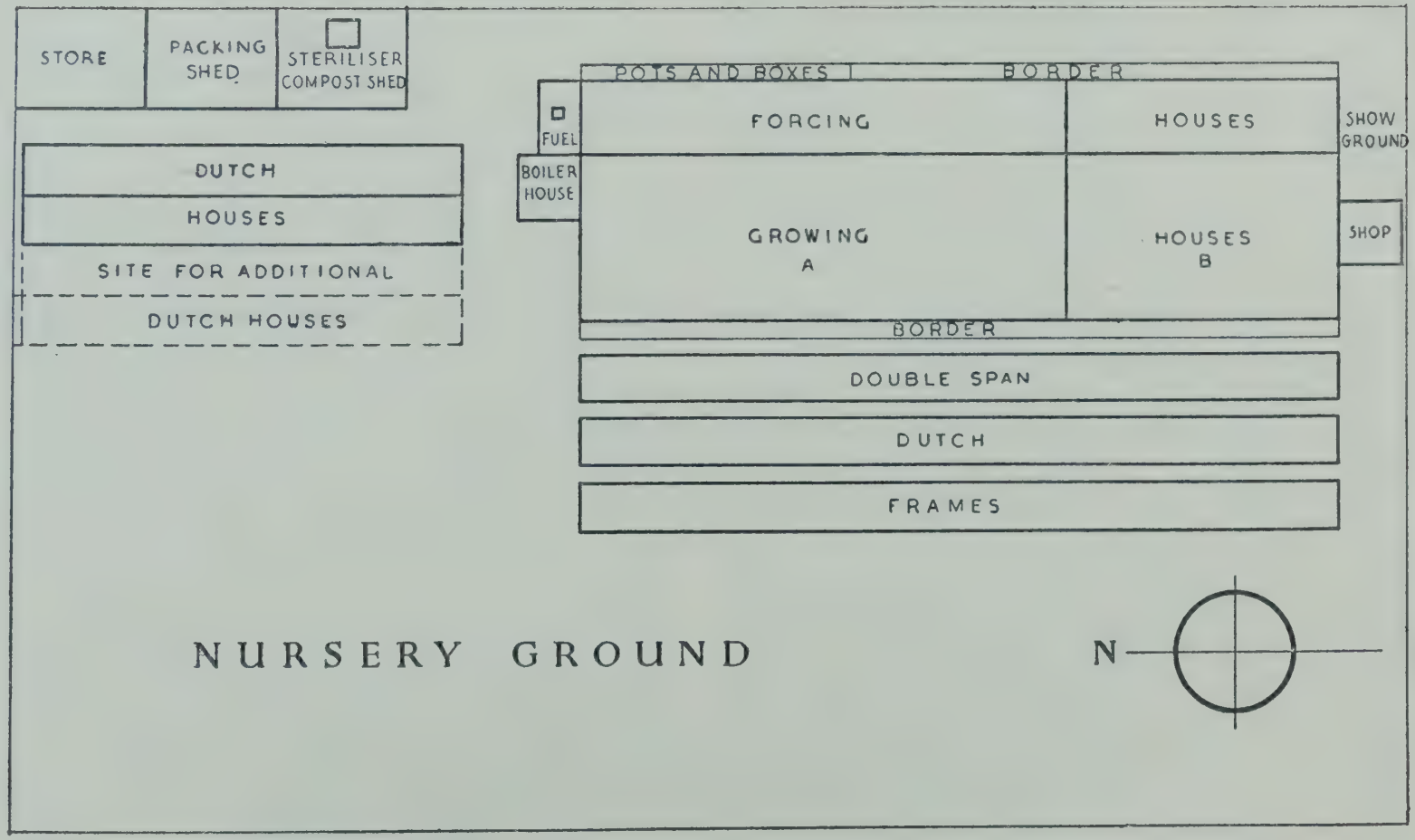
It is not suggested that the above plan should be slavishly followed. Indeed, there are many sites and situations for which it would be quite unsuitable. Each site presents its own possibilities and limitations. Provided the salient factors bearing on economy of working, maximum utilization of space, effective display of wares, and the welfare of the plants are considered the plan is capable of wide variation.

CHAPTER IV

NURSERY BUILDINGS

In this chapter we are to examine in somewhat greater detail the structure of modern commercial horticultural buildings. Those who are examining commercial greenhouses for the first time and who have hitherto been familiar only with the types of greenhouses erected in private gardens are often struck by the apparently flimsy structure of the former. But the appearance of flimsiness is only apparent, and not real. In the design of modern commercial houses every stress and strain is known and allowed for, with a suitable margin of safety, in their design and construction.

The guiding principle in designing a commercial glasshouse is to offer the minimum obstruction to light consistent with structural strength. The glazing bars carry the whole of the weight of the glass; there are no wide and deep intermediate rafters to obstruct light. Where the width of the house exceeds 15 ft. additional support to the slender glazing bars is provided by longitudinal purlins, supported by purlin posts at intervals of about 6 ft. The purlins are no larger than 2 in. by 3 in., and the purlin posts are often formed from 1½ in.-iron tubing set in concrete. The outward thrust of the roof—or, as it is often called, the roof spread—is counteracted by 1-in. wrought-iron bars at intervals of about 12 ft., secured by coach-bolts to the eaves-plate and wall-plate and set in concrete. These points are illustrated in the sketch on page 34, which is a cross-section of the main houses in the



A Good Lay-out for a General Nursery.

C. Harris

Manure is essential as a base food for the soil. In conjunction with fertilizer, it provides a blend that is properly balanced. Manure on its own is not enough for most crops.

Cucumbers are planted 9 ins. from the glass and trained up canes to wires that run up the underside of the roof. Fruits should be at least 1 ft. long for market.

Courtesy Carters Tested Seeds and Smallholder

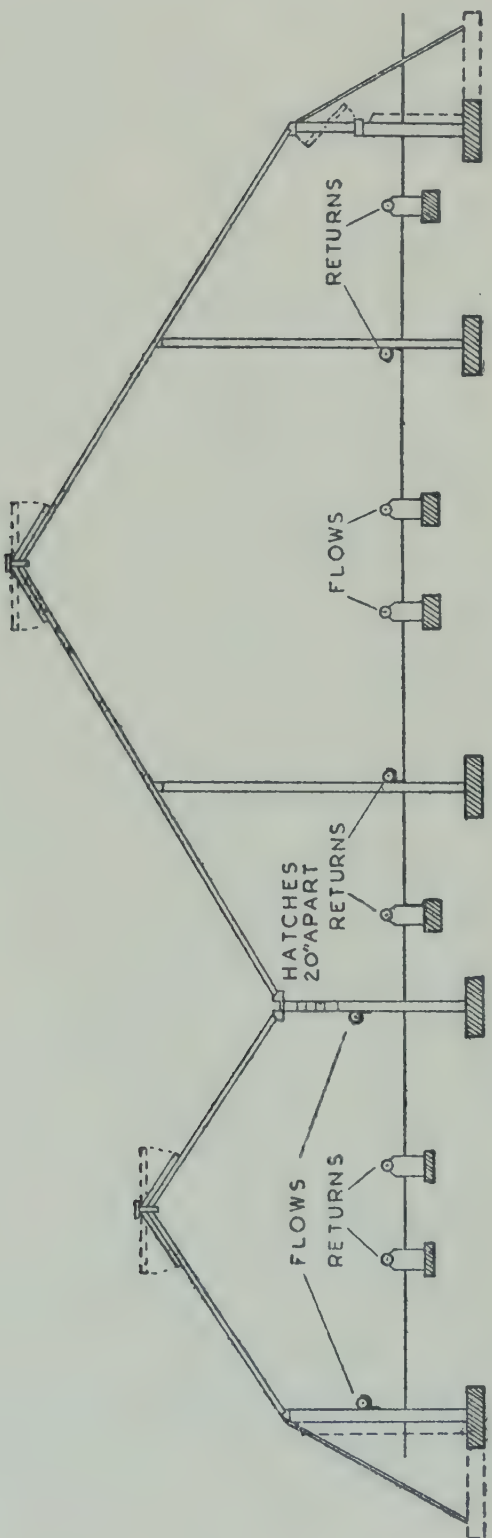
plan reproduced on page 32. In these houses the glass of the growing-house is carried to within 2 ft. of the ground line. In the forcing-house the brick wall is carried to the eaves. The base or wall plate is secured by bolts to $4\frac{1}{2}$-in. brickwork.

The best—indeed the only—wood for commercial greenhouses is best-quality seasoned red deal for glazing bars and ventilators and pitch-pine for wall-plate, eaves-plate and ridge. Some attempt has been made to popularize other woods, but the commercial growers remain to be convinced of their advantages.

In large houses of the type shown on page 34, to be used for tomatoes, chrysanthemums, lettuce, pot plants, carnations and similar crops, the maximum winter temperature that is necessary and can be economically maintained is about 60° Fahr. day temperature and 55° Fahr. night temperature. This is achieved by six 4-in. pipes running the length of the house, two flows, one on either side of the path, and four returns disposed equally over the ground area. The pipes are supported on the purlin posts and on concrete pillars. (Hot-water pipes must only rest on the supports, and must not be secured to them in any way, as they must be free to expand and contract with differences in temperature.)

In houses where all the crops are to be grown in beds, such as tomatoes and lettuce, there is no need to provide tanks for water storage inside the houses. The crops are watered either with a hose-pipe secured direct to taps placed at strategic points or, as in the modern way, through overhead sprinklers.

For seedlings and young plants growing in pots many growers prefer to use water from which the chill has been taken, and this involves installing tanks of a capacity of 50 gallons or so. (The benefits of heating water for



Cross-section of Forcing- and Growing-Houses.

established pot plants are doubtful.) These are conveniently placed at opposite corners of the house. Taps are also provided for watering through the hose-pipe established pot plants and plants in beds when the house comes to be occupied with such.

Ventilation in the growing-house is provided by ventilators in the side—used only in the height of summer—and ventilators in the roof on either side of the ridge. The latter are lifted by a patent lifting gear, extraordinarily light in construction yet positive in action, operated by levers at the end of the house. Those who have had the unenviable task of trying to maintain an equable temperature in a small greenhouse will be agreeably surprised at the ease with which this may be done in a large commercial house. The reason is that the larger volume of air heats up and cools down much slower. Even on a typical April day, when bursts of brilliant sunshine alternate with periods of an overcast sky, the temperature fluctuations are insignificant.

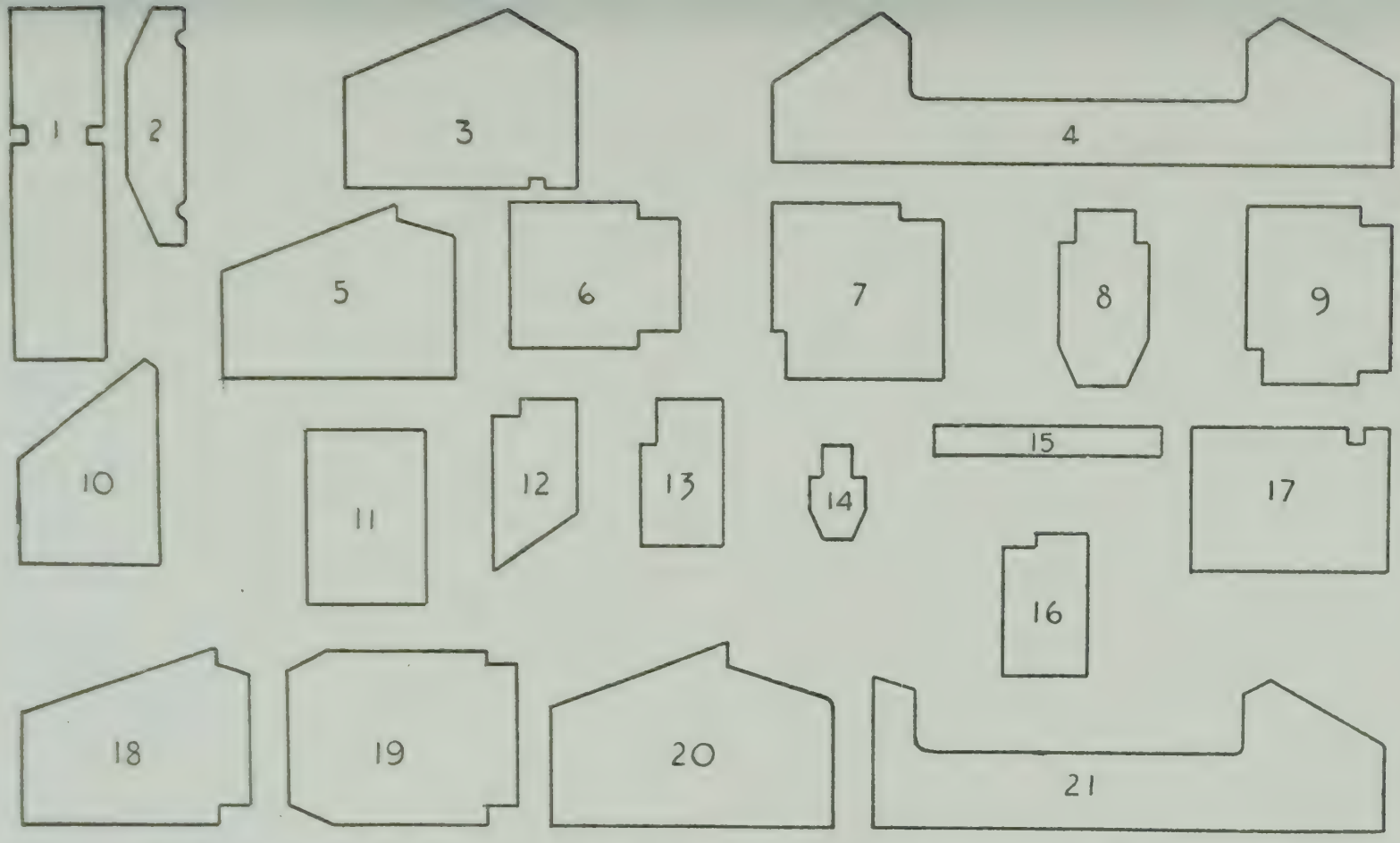
Turning now to the forcing-house, this is of somewhat different plan, for it is kept at a higher temperature, and conservation of heat is a factor to be studied in the design. It will be seen that the brick wall is carried up to the eaves-plate; there is no side glass or ventilators. The reason for this is that thin glass is a very poor insulating material and losses of heat through it are very high. Conversely, a brick wall, only $4\frac{1}{2}$ in. thick, as are the walls of the above houses, is a better insulator, and heat losses through it are relatively small. In tomato and lettuce houses the necessity for abundant light overrides all other considerations, but the light factor—while still important—is not quite so vital in cucumber and forcing-houses, and the saving of heat by cutting down the area of glass is established practice in these.

As will be seen from a comparison of the dimensions of the houses, cucumber houses are narrower and lower than tomato houses. No purlins and purlin posts are necessary, but similar provision against outward thrust or " stretch " is made as in the larger house, but only one bar, secured to the eaves-plate, is used.

Ventilators, operated by outside lever, are fitted to both sides of the ridge.

For winter and spring cucumbers and for forcing generally a day temperature of 65–75° Fahr. and a night temperature never much below 60° Fahr. have to be maintained. To attain and keep this in all kinds of outdoor conditions—including the worst of all, a freezing wind—plenty of pipe area is necessary. A usual arrangement is flows on the walls beneath the gutter and returns along each side of the path. In exposed places more pipe area may be necessary. These provide the heat essential for forcing. Water service may consist of tanks at each end of the house and a tap in the centre, or the former and overhead sprinklers. The latter are greatly to be desired as providing a ready means of maintaining the necessary humidity.

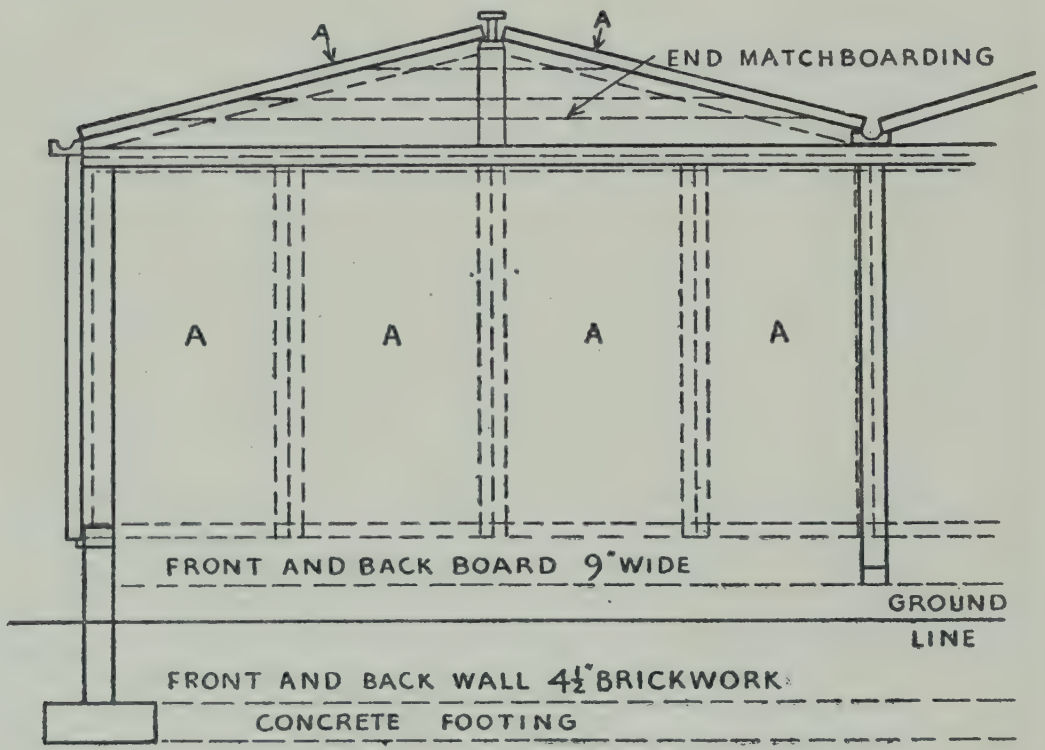
Next to be considered are the type known, from their country of origin, as Dutch houses. These are a comparatively recent importation into the British nursery, but they are proving immensely valuable. Before war put a stop to developments the area being put down to Dutch houses each year must have totalled some hundreds of acres. The essence of the original Dutch house is its portability, and the fact that the lights are standard and interchangeable with the lights of Dutch frames. Also extension is easily effected simply by adding more sections, as all the units in the structure are a standard size. A typical Dutch house cross-section is shown in the sketch on page 38.



STANDARD SECTIONS OF TIMBER USED IN THE CONSTRUCTION OF COMMERCIAL GLASSHOUSES.

(1) Ridge; (2) Capping; (3) Side Plate; (4) Gutter; (5) End Plate; (6) Strengthening Rafter; (7) End Rafter; (8) Sash Bar; (9) Division Rafter; (10) Purlin; (11) Purlin Post; (12) Vent Top Rail; (13) Vent Style; (14) Vent Sash Bar; (15) Vent Bottom Rail; (16) Vent Seat; (17) Door Frame; (18) Transome; (19) Mullion; (20) Sill; (21) Outside Gutter. [*By courtesy of Duncan Tucker Ltd., Tottenham.*

The standard Dutch light—used for both Dutch houses and Dutch frames—consists of a single pane of glass set in framework of wood measuring 4 ft. 11 in. in length by 2 ft. $6\frac{3}{4}$ in. in width, these being outside dimensions. For the Dutch house a skeleton framework is bolted together and the lights are secured to this. A proportion of the lights are left free to open for ventilation. When the



Cross-section of a Dutch-Light House.

house is to be a fixture it is often built on a brick or concrete foundation; where it is intended to be portable, stout stakes are driven into the ground, and the bottom timbers of the house secured to these.

As first used in this country the essentially portable character of the prototype was retained and the framework was invariably of wood. The type has, however, proved so successful for many crops, notably tomatoes and

lettuce, that a semi-permanent character is now often given by forming the framework of pre-cast reinforced concrete sections. These, however, bolt together, just as do wood sections, etc., and if and when the necessity arises the house can be readily moved from one site to another. Concrete sections provide that degree of weight and indestructibility which an all-wood structure lacks.

Due to their large area of glass, Dutch houses are not very economical to heat, particularly to maintain the temperatures needed for very early crops. They are perhaps most valuable for spring lettuce, main-crop tomatoes and early winter chrysanthemums. For the crops mentioned a single circuit of 4-in. pipe in each unit about 1 ft. above soil level is sufficient to maintain a dry atmosphere for early winter flowers and to keep out frost.

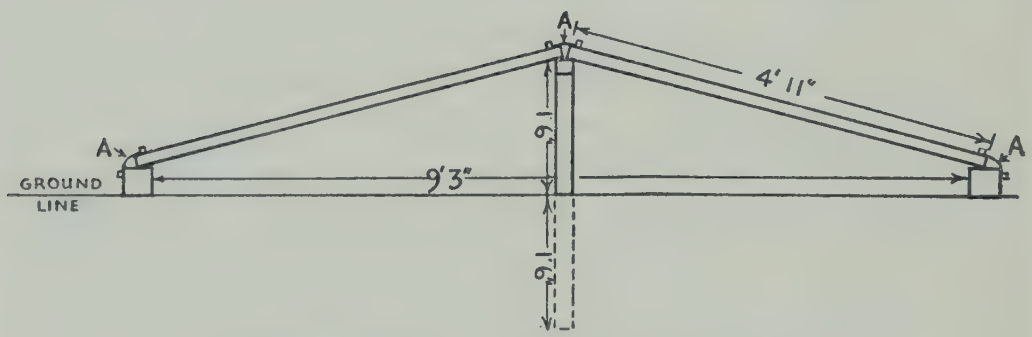
Coming now to frames, possibly the only frame with which the reader is familiar is the type found in private gardens with light-excluding glazing bars set sometimes as close together as 10 inches. Such are never found in the up-to-date nursery. All the frames, for whatever purpose they are used, are of the Dutch type, in which the lights are formed of a single large pane of glass fixed in wooden frames of the standard size—4 ft. 11 in. by 2 ft. $6\frac{3}{4}$ in. Not only is the Dutch frame much cheaper than the private garden type, but plants grow far better in them. Light is one of the principal raw materials of plant growth, and in the Dutch frame the plants receive the maximum.

On page 40 is shown a cross-section of a single-span-roof frame. Dutch frames are often span-roofed, though where space is restricted there are no inherent objections to a single row of lights, except that it involves making an unproductive light-absorbing back wall.

In the span-roof type the framework to carry the lights consists of a ridge-board supported by posts at intervals

of about 10 feet, and eaves-boards which rest on the ground. If the frames are to occupy one site for any length of time the eaves-board should be replaced by a pre-cast concrete wall. The ends of the frames are filled in with match-boarding.

Some nurserymen heat a proportion of their Dutch lights by a flow and return of 2-in. pipe along the centre immediately beneath the ridge-board. The writer, however, lacks information that any return commensurate with the outlay and overhead charges for firing is obtained. The same amount of heat applied to a Dutch house would



Cross-section of a Dutch-Light Frame.

probably yield a far greater return. Some success, notably with lettuce, has been obtained by low-consumption electric soil-heating cable. At the time of writing this is still in its experimental stage, and apart from recording here that to the best of my knowledge preliminary experiments have proved eminently promising, I will leave the subject.

Lastly come the appliances called cloches. These, particularly in the form of the continuous type, are now familiar to all. They usually consist of panes of glass held by a wire frame or other means, and are of sizes and shapes handy for moving rapidly from place to place. They are dealt with in detail in a later chapter.

CHAPTER V

DATA FOR HEATING GLASSHOUSES

For greenhouses—other than perhaps the very cheap Dutch type—to repay their cost and upkeep they must be used for the more expensive crops, and this implies heating. Whilst the nurseryman is not expected to be a heating engineer, a knowledge of the subject is of value, and one can thereby avoid many costly blunders and mistakes.

We may perhaps best approach the subject by first noting one or two points which lie at its root. First, by heating a greenhouse we mean raising the temperature of the air within the greenhouse several degrees higher than that of the air outside the greenhouse. In other words, we create a block of warm air within an infinitely larger block of cold air; the warm air is contained and prevented from becoming diluted with cold air by the separating partition of glass and brick walls; such is an ideal picture.

But in practice the ideal is unattainable. There is exchange, and consequential dilution, with the outside air; this is a source of loss of heat, and unfortunately it is not the only source. Heat is also lost by transmission through the medium separating the warm and the cold air, and glass of the type used in horticultural buildings transmits heat very readily. So in maintaining a greenhouse at a temperature of, say, 30° Fahr. higher than the outside temperature we have to make provision for considerable losses of heat, and these losses are going on

continuously so long as the temperature outside the greenhouse is lower than that we desire to maintain inside it.

The rate of heat-loss is naturally greatly affected by good or bad construction of the greenhouse. Well-fitting doors, glass carefully bedded and tightly sprigged down, ventilators accurately fitted will reduce it to a minimum. But even when construction is of the best the heat-loss is still considerably higher than from, say, a centrally heated brick dwelling-house. The amount of heat lost through glass is, in fact, twice the amount lost through a $4\frac{1}{2}$-in. brick wall, and nearly three times the amount lost through 9-in. brickwork.

To these losses must be added the losses by direct exchange with the outside air. This is called the air change; in most greenhouses when the ventilators and doors are closed one may calculate that the whole of the air is changed twice every hour—that is to say, a volume of air equal to twice the cubic volume of the greenhouse has to be raised from outside to inside temperature every hour. In certain circumstances—for example, when a cold wind is blowing—the air-change may easily rise to four times per hour.

It will be seen from the above that greenhouses are very expensive to heat. Next to wages, fuel is the heaviest item on the nurseryman's debit account. As I said at the opening of this chapter, it behoves the nurseryman to know something about the theory of heating, so that he may know what he is up against and how he can plan for the utmost efficiency and economy.

Heating a Growing-House

For purposes of illustration we will take first the growing-houses shown on page 34. We remember that these together measure 140 ft. long, 30 ft. wide, 13 ft. to ridge,

5 ft. to eaves. 2 ft. of this latter is $4\frac{1}{2}$-in. brickwork and 3 ft. glass and wood. By calculation we find that the total outside surface area of approximately 6030 sq. ft. is made up of 5630 sq. ft. of glass and 400 sq. ft. of $4\frac{1}{2}$-in. brickwork. To arrive at useful data for expressing gains and losses of heat we use the British Thermal Unit—usually abbreviated to B.T.U.—which is the amount of heat required to raise the temperature of 1 lb. of water 1° Fahr.

When the difference between inside and outside temperature is 30° Fahr. each square foot of glass transmits approximately 32 B.T.U.'s per hour. By a simple calculation we can now estimate the loss of heat by direct transmission when the outside temperature is 30° Fahr. lower than the temperature which we wish to maintain in the house: it is 5630 ft. × 32 = 150,160 B.T.U.'s and 480 sq. ft. × 16 = 6400 B.T.U.'s making a total loss of 186,560 B.T.U.'s per hour.

To this we must add the losses arising from air change. To arrive at this we must find the number of cubic ft. of air in the house, multiply this by the number of changes per hour, and the result by the number of B.T.U.'s required to raise 1 cub. ft. of air 30° Fahr.

The houses contain 39,900 cub. ft. of air. If this is changing twice per hour, we find that we have to raise the temperature of 79,800 cub. ft. of air 30° Fahr. per hour to meet this loss.

To raise 1 cub. ft. of air 1° Fahr. requires approximately 0·02 B.T.U. per hour. To raise 1 cubic ft. of air 30° Fahr. will therefore require 6 B.T.U.'s. To make good the loss from the two changes per hour in our greenhouse will thus need 23,950 T.B.U.'s per hour.

The total theoretical loss of heat from the house we have taken for our example, when we desire to maintain it at

60° Fahr. when the outside temperature is 30° Fahr., is thus 210,510 B.T.U.'s per hour.

Heating Values of Fuel

Now, this loss of heat has to be made good, or inevitably the temperature of the house falls. It is made good by burning fuel which contains stored-up heat and transmitting that heat to the air in the greenhouse. We see, then, that we now have two factors to consider—viz., the *production* of heat, and the *transmission* of heat.

We know fairly exactly the amount of heat, expressed in B.T.U.'s, in the most popular kinds of fuel. I have set them out in the following table:

Kind of Fuel.	Total B.T.U.'s from 1 lb.
Anthracite . . .	14,700
Coal (best . . .	14,150
,, (ordinary) . .	12,500
,, (poor) . . .	10,000
Coke (best) . . .	14,000
,, (ordinary) . .	12,500
,, (poor) . . .	9,000
Fuel Oil . . .	19,000

If we could obtain the whole of the heat in the fuel we should be able to make good the losses in the growing-house by burning approximately 10 lb. of anthracite, best coal, or best coke per hour, or approximately 1 cwt. per night of eleven hours, and a correspondingly smaller amount to make good the losses in the forcing-house. But unfortunately we do not obtain the whole of the heat in the fuel; far from it. For the types of boiler most commonly found in small nurseries 60 per cent. efficiency is the most one can expect, and it is safer to calculate on

the basis of 50 per cent. efficiency.* That is to say, only half the potential heat in the fuel will be actually transferred to the water; the rest is wasted in various ways, such as incompletely burnt gases, gases passing to the flue before they have parted with all their heat, and so on. So we see that to make good the losses of heat from the growing-house under the conditions noted above we shall have to provide for the combustion of about 30 lb. of anthracite, best coal, or best coke per hour. The growing-house and the forcing-house in the lay-out described in Chapters II and III call for a combustion of fuel at the rate of about $\frac{1}{2}$ cwt. per hour to maintain the growing-house at, say, 50° Fahr. when the outside temperature is 25° Fahr.—i.e., a difference of 25° Fahr., with a boiler efficiency of 50 per cent.

The most popular fuel for hand-fired boilers is coke. It is cheaper than anthracite and yields a higher efficiency than coal. For the rest of this part of our subject we will consider best coke to be the chosen fuel. A cubic ft. of coke (broken) weighs 30 lb. To ascertain the size of boiler required to consume the necessary amount of fuel we multiply pounds of coke needed per hour by the number of hours between stoking and divide by 30; this gives the number of cubic feet of fire required. In the above example we need to consume 56 lb. of coke per hour and we desire, say, five hours between stokes, so we get the result $56 \times 5 = 280 \div 30 = 7$ cub. ft. In the boiler 60 per cent. only of the fire-box is calculated as occupiable by fire, so we need boilers with fire-boxes of approximately 10 cub. ft. total.

* The writer is aware that higher efficiencies than these are sometimes claimed by manufacturers of boilers, and these claims may be justified. On qualified advice, however, he thinks it in the reader's interests to adhere to the figures given.

A Suitable Type

A type of boiler very popular with nurserymen which would appear to meet the above requirements has approximately 10 cub. ft. fire-box space and produces approximately 290,000 B.T.U.'s per hour. This gives us a reserve of 12,900 B.T.U.'s. In practice, however, it would be found that the boiler was not up to the task on many occasions. The outside temperature can fall far below 25° Fahr. in many parts of the country; a cold wind can increase the heat loss 100 per cent.; a little indifferent fuel mixed with the good fuel can lower the B.T.U. output by 10 per cent.

The prudent planner will install a boiler or boilers of at least 50 per cent. greater rated capacity than that theoretically required, and if the money can be found, boilers of 100 per cent. greater rated capacity than theoretical requirements will prove a sound investment. Such will increase the number of hours between stoking by 100 per cent. Their overplus of power will make automatic draught control possible—and this produces enormous saving in fuel. They will provide for wellnigh every contingency of outside weather conditions, and there will be far less clinker formed.

Lastly we come to the transference of the heat produced in the boiler fire-boxes to the air in the greenhouses. The invariable method is by water circulating through 4-in. iron pipes. It is obvious that only the pipes in actual contact with the greenhouse air are useful in raising and/or maintaining its temperature. In calculating the length of pipe required we therefore consider only the pipes actually exposed in the greenhouse.

We have first to note that the quantity of heat radiated from the pipes is dependent on the temperature of the

pipes. A usual and economic temperature is 140° to 160° Fahr.; temperatures much higher than this "dry" the atmosphere too much, and temperatures lower than this are uneconomical. One ft. run of 4-in. pipe radiates 170 B.T.U.'s per hour in a temperature of 60° Fahr. The growing-houses on page 34 contain approximately 840 ft. run of exposed 4-in. pipe. At a water temperature of 140° Fahr. the pipes are thus radiating 142,800 B.T.U.'s per hour. This is ample for average conditions. When the outside temperature falls, the temperature of the water has to be increased if the house is to be maintained at the same temperature.

The forcing-house contains approximately 560 ft. run of 4-in. pipe. With a water temperature of 140° Fahr. 95,200 B.T.U.'s are being radiated. The heating is thus well on top of its job—which is what we want in a forcing-house.

Inasmuch as only the exposed pipes in the glasshouses are radiating useful heat, losses of heat from service pipes and the surface of the boiler should be cut down to a minimum by covering these with insulating lagging.

To sum up this chapter we may say that the essence of planning a heating system is to ensure that losses of heat are counterbalanced with an ample reserve by sufficient space in the boiler fire-box for heat production and sufficient pipe area for its transmission without raising the temperature of the water too high.

The same rules apply where the house is a small lean-to house in a suburban garden as where it is a range of glasshouses acres in extent.

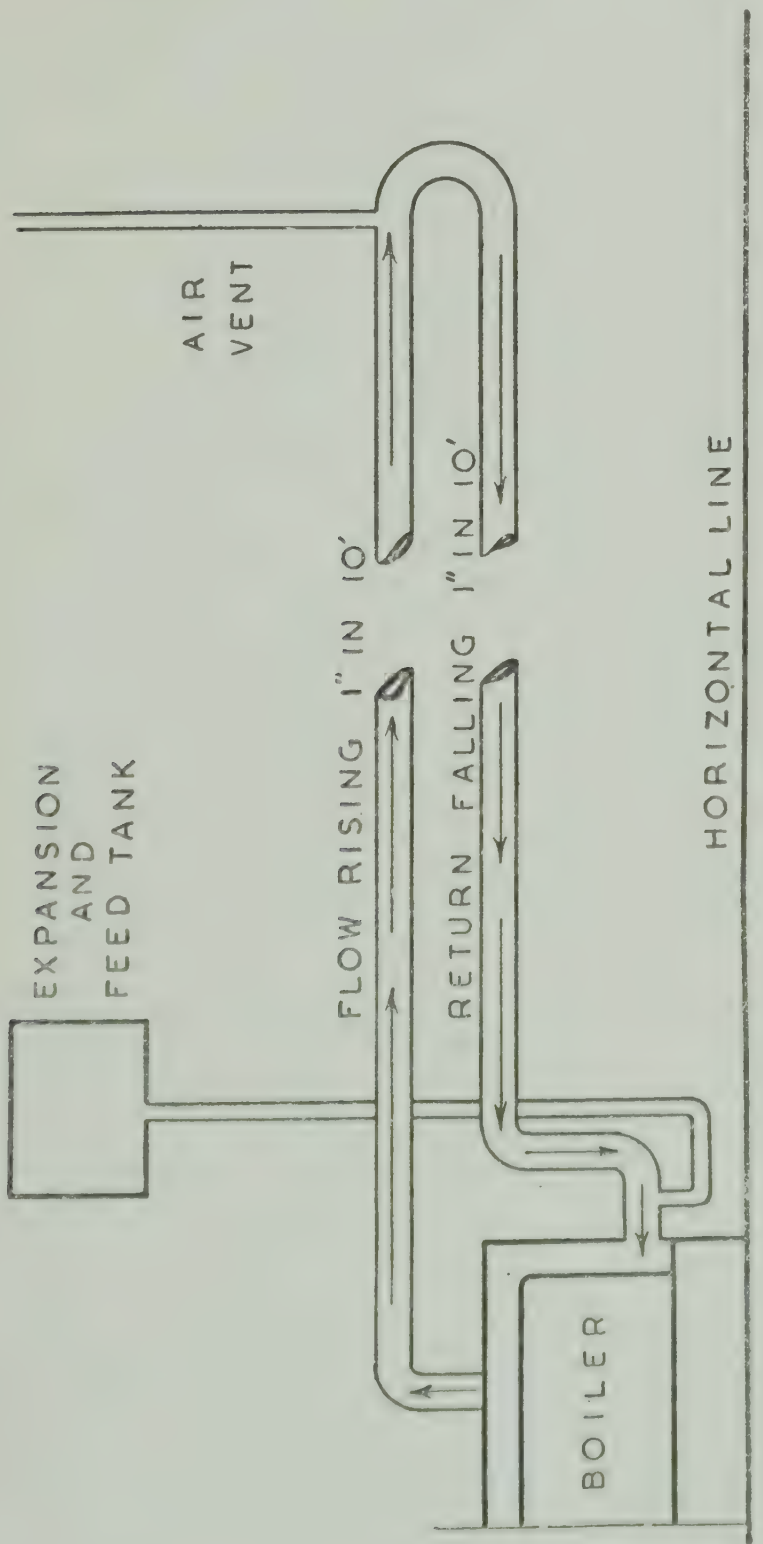
CHAPTER VI

INSTALLING HEATING APPARATUS

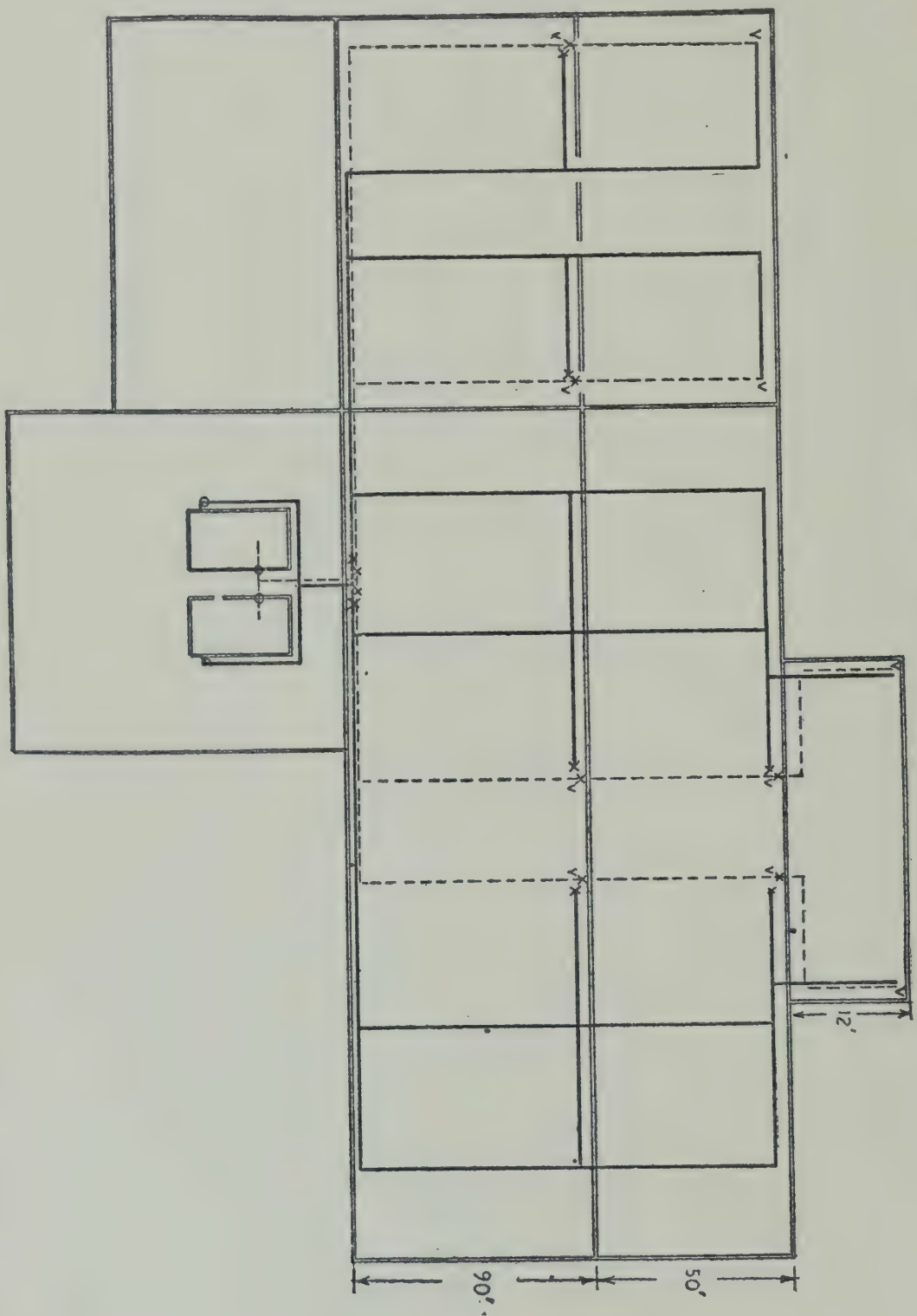
WHILST I do not for a moment suggest that the reader should attempt to install heating apparatus himself—unless he happens to have had experience of this work—a knowledge of the rules and principles is useful, if only to provide information for planning and designing his nursery.

Small heating installations, such as come within the scope of this book, are of the low-pressure gravity type—that is to say, the circulation of the water round the pipe circuits is maintained by the phenomenon of hot water rising to the top of the circuit and cool water falling to the bottom of the circuit. A simple illustration is given on page 49.

As water is heated in the boiler it passes into the flow-pipes of the circuit, where it loses a proportion of its heat by radiation and the cooled water returns to the boiler through the return pipes. The flow-pipes must therefore rise from the boiler for all of their length and the return pipes must fall to the boiler. The efficiency of the circulation depends to a considerable extent on the setting out of the flow and return pipes. A heating scheme for the houses shown on page 34 is set out in the sketch on page 50. The flow-pipes have an initial rise of about 2 ft. height. Then they rise about 1 in. in 10 ft. throughout their length, giving a total rise from the boiler of about 4 ft. The fall of the return pipes is also 1 in. in 10 ft. The return pipes must fall throughout their length; that is to say,



Heating Installation of Low-pressure Gravity Type.



HEATING INSTALLATION FOR FORCING- AND GROWING-HOUSES.

there must be no water below the level of the boiler bottom, or circulation will be impeded.

Where the head of water is less than 15 ft. the type of pipes in which the joints are made with rubber rings may be used. These are very easy and quick to assemble, and have the further advantage that if a defect develops the defective pipe may be removed without disturbing the other pipes. Also extra junctions, and so on, can be easily inserted. When the head of water exceeds 15 ft.—that is, the expansion tank is 15 feet or more above the boiler—spigot and socket pipes must be used and the joints made with cement.

As mentioned before, the pipes must only rest on the supports, and allowance must be made for expansion. The approximate expansion of iron pipes when heated from cold to 180° Fahr. is $1\frac{1}{4}$ in. per 100 ft.

If it is desired to paint the pipes after erection use "vegetable black". On no account use bituminous paints or paints with a high oil-content, as the fumes from these will scorch tender young foliage. Aluminium paint should not be used, as it lowers the heat emission of the pipes by as much as 15 per cent.

A vital part of the heating installation is the feed and expansion tank. As is well known, water expands with changes in temperature above or below 39° Fahr., and provision must be made for this expansion; also for ensuring that the installation is always full of water.

Allowing a reasonable safety margin, the expansion should be calculated as equal to 1 gallon in 24 gallons. That is to say, if an installation contains 24 gallons of cold water, an expansion tank of at least 1 gallon must be supplied. For larger installations the size of the expansion tank required may be calculated from the formula—

100 ft. of 4-in. pipe contains approximately 55 gallons of water. So a heating installation of 1000 ft. of 4-in. pipe will, when a suitable addition is made for the water in the boiler and service pipes, need an expansion tank of at least 25 gallons capacity. Such a tank will measure 2 ft. long, 1 ft. wide and 2 ft. deep, and when full will weigh about 270 lb.

The expansion tank also serves as a feed-tank; the usual arrangement is for the water in the tank to be maintained at a constant level by a specially made ball-valve, and an overflow pipe fitted to take away the expansion water above the capacity of the tank. The cold feed-pipe is connected to one of the return pipes as near the boiler as practicable.

Many heating engineers recommend fitting an altitude gauge on the boiler. This is a device to indicate the head of water in the system; for example, if the water in the feed-tank is 14 ft. above the top of the boiler the pointer on the gauge will indicate 14 ft. head of water. The gauge has two fingers, one set by hand to the appropriate figure which is indicated by the second finger—which moves with the change in water head—when the pipes and feed-tank are full. Henceforward the two fingers will remain together if all is well; if the movable finger indicates, say, 13 ft. head when the fixed finger shows 14 ft. head, then we know that something is wrong, and we have a chance to put it right before the head falls to a dangerous level. These devices are quite cheap and reliable.

On each flow-pipe an air-vent must be fitted at the highest point of each circuit. These pipes may be carried above the expansion tank, then bent over to discharge any water into it, or they may rise to the necessary height and terminate in an inverted U bend. They should be protected from frost if outside the house, but the obvious

arrangement is to have both feed-tank and air-vents inside a heated house.

On no account should the drawing of water from the system for pot-washing and the like be allowed, or rapid incrustation of boiler and pipes, with consequent deterioration in efficiency, will follow. For the same reason the installation should be drained only for necessary repairs or if it is idle during frosty weather. The ideal is to have an expansion tank large enough to accommodate normal expansion, so that only losses arising from evaporation have to be made good.

Coming next to the boiler-house, the centre of this is the boilers. In gravity systems they must be below the level of the return pipes, and an initial rise of at least 2 ft. is a great advantage in securing a good circulation. This can easily be managed where the boiler can be placed, say, 6 feet below ground level, but often compromise is necessary. However, if the boiler is placed as low as possible consistent with the structure of the boiler-house, then one has done all one can.

In the heating plan of the general nursery on page 50 the boiler tops—that is, the flow outlets—are about 3 ft. below the flows in the houses. Unless there are difficulties with a high-water table which makes the construction of an underground boiler-house difficult this should be taken as the minimum.

Where the boiler has to be kept near the ground line the difficulty of obtaining a circulation is overcome by having a loop pipe rise to 6 or 5 ft. and then fall at once to the pipe level in the house, and all the pipes in the house then become " returns ", in that they fall to the boiler. This arrangement, whilst quite common in factories near rivers and other places where a boiler-house below ground spells difficulties, is not liked much in horticultural work, in

which the comparatively even dissipation of heat from gently rising flows and gently falling returns seems to accord more with the needs of glasshouse heating.

In an installation in which several houses are heated from one boiler, valves must be inserted in the circuits so that the flow of heat into the different houses may be regulated or cut off entirely. First, each complete circuit will have its own outlet from the boiler, and will be controlled by a valve of the type known as " screw down " or " gate valves "; these are positive in action, and can be used to completely cut off the water in the circuits when repairs are to be effected to the boiler, thus obviating the need of draining the whole system. Then when the two or more houses are heated from one flow exit from the boiler, valves may be fitted which enables one house—the house farthest from the boiler—to be cut out. The valves to effect this should be in both flow and return circuits, and the flow must have an air-vent fitted so that provision for feeding and expansion remains effective. Lastly, when more than one flow is fitted, as is sometimes done in a forcing-house, the extra flows should be fitted with valves, so that they may be cut out if the extra heat is not required. All these valves should be of the butterfly-throttle type, which, when open, offers the minimum obstruction to the free flow of water.

The bunker and boiler-house in our general plan are large enough for an automatic stoker of the under-feed type if the reader desires to install such. These were at one time a very attractive proposition, for they enabled a very cheap fuel to be economically burned and good regulation of heat to be obtained. But they have been installed in such numbers that some collieries now ask double the price for the fuel suitable for the stokers—and are able to get it. I believe—though I am, of course, open to cor-

rection—that automatic stokers burning washed slack do not now show quite such an overwhelming superiority over hand-firing, using best gas coke, as they did, say, ten years ago. However, whether or no an automatic stoker is ever installed, plenty of room in a boiler-house is a good thing.

For ease of firing, the boilers should be set at a right angle to the bunker opening, and not too near nor yet too far away for firing to be done easily and with economy of movement. Entry to the boiler-house may be by steps or vertical iron ladder. The former is the most convenient, whilst the latter is more economical of space.

In either case the entry should permit of the easy movement of large and weighty boiler sections into and out of the boiler-house. The boiler-house must be adequately ventilated, for the fumes from both coke and coal—particularly the former—are dangerous to health and even to life.

No part of the boiler-house should be of wood; walls and roof should be of concrete, and doors should be of sheet metal.

The chimney-flues may be of brick or iron piping and of a height and area sufficient to provide an adequate draught. Each boiler must have its separate flue. Suitable flues for the installation shown on page 50 will together measure 14 in. by 9 in. and 20 ft. high.

Provision should be made for scraping and sweeping the flues, and if they are of brick, the inside joints should be struck off smooth so that no rough surfaces are left to impede a free flow of air or to encourage soot building up. The flues must be absolutely air-tight, and the entry of the iron boiler flue into the brick flue must be well made and sealed with heat-resisting cement.

CHAPTER VII

CONCERNING THE SOIL

NOTHING perhaps distinguishes modern commercial horticulture so much as the great care that is taken to produce and maintain soil health and fertility. The private gardener—or his employer—may say that he cannot afford the time or labour or materials for keeping the soil clean and fertile. The commercial grower knows that he cannot afford *not* to see to these things; if he does not already know it, bitter experience will teach him.

Soil health means freedom of the soil from pests and diseases harmful to crops and a physical condition favourable to root action. Fertility means these things and also the presence of plant nutrients in quantities sufficient to produce abundant crops. A vast amount of work has been and is constantly being done on both these aspects. Here we are to summarize it briefly so that the reader may from the beginning adopt the right attitude towards the problems.

SOIL STERILIZATION

First as to pests and diseases whose home is the soil. Practically every important horticultural crop is liable to be attacked by pests or diseases originating from the soil, and the probability of attack and its violence are greatly increased by the intensive systems of growing the crops. The only measures that are generally possible against these maladies are *preventive*. Only very rarely is it possible to save a crop that is affected. The reason is,

of course, that the organisms causing the damage are out of the reach of spray fluids or fumigants, such as can be applied to pests and diseases attacking leaves and stems. The enemies must be killed before the crop is planted, or, better still, prevented from ever occurring in dangerous numbers. To achieve this the soil in glasshouses and frames and to some extent outside is "sterilized" periodically. Also all soil used for potting and nursery boxes is sterilized, as are the pots and boxes used. This may sound very laborious and expensive, but in actual fact it is profitable. The increase of crop and greater health of plants, not to mention the complete absence of weeds, give a return which amply repays the cost of labour and materials used in soil sterilization.

The methods of soil sterilization in general use are (*a*) by heat and (*b*) by chemicals.

In sterilization by heat the soil is raised to a temperature of 180–212° Fahr. and kept at that for about twenty minutes by passing steam through it. This kills all harmful soil organisms and weed seeds. It also has an effect on soil fertility which will be noted below.

The apparatus for steam sterilizing soil in small quantities to be used for potting and boxes is comparatively cheap, and may in fact be constructed by a handy man for himself. A structure based on the one designed at the John Innes Horticultural Institution * consists of a fire-grate something like that of the domestic copper, with a combustion space. Over this is a shallow compartment containing water. Above, and separated from the water compartment by a perforated iron sheet, is the soil compartment. When the apparatus is to be used the water compartment is nearly filled, the perforated sheets placed

* Full details of this sterilizer are obtainable in a leaflet published by the John Innes Horticultural Institution, price 6*d*.

in position, the soil compartment filled level full with the dry soil to be sterilized, the soil covered with old sacking and the fire lit. The steam percolates through the soil and raises its temperature to 180° Fahr.; this temperature is maintained for twenty minutes, to ensure that every particle of soil makes effective contact with the steam.

A thermometer is used to indicate when the temperature is reached. The sterilized soil is removed, the water-chamber refilled and another lot of soil put in. Sterilizers based on the same principle as the above but built entirely of metal are available. It should be noted that the ingredients of potting composts are sterilized separately before mixing.

For Larger Quantities.

For sterilizing larger quantities of soil for pots and boxes somewhat more elaborate and costly apparatus is justifiable. This takes the form of a boiler capable of raising steam to about 70 lb. per sq. in. pressure; the steam is led through a pipe to the soil container and is discharged into the body of the soil through a grid formed of pipes in which small holes are bored. Very large quantities of soil can be dealt with quickly with such an outfit. One may begin with the smaller type and install the larger type when circumstances warrant it.

The sterilization of soil by steam in glasshouses and frames involves the purchase of fairly costly equipment if one is to rely entirely on one's resources. A boiler able to raise and maintain a steam pressure of 70 lb. per sq. in. and with an evaporative capacity proportionate to the size of the nursery is necessary, with piping to lead the steam to the soil and to distribute it through the body of soil being sterilized. It is, however, possible to hire suitable boilers in many places, and some County Horti-

cultural authorities are hiring out complete equipment to growers at reasonable rates.

The actual methods of distributing the steam through the soil to be sterilized vary with different equipment. Some are designed to sterilize deeply and some more shallowly. The whole procedure requires to be done thoroughly, and the reader is advised to consult his County Horticultural Adviser before either purchasing equipment or attempting to do the job himself. Much valuable information is contained in the Ministry of Agriculture Bulletin No. 22.

Chemical Sterilization

Steam sterilization of glasshouse and frame soil is not usually necessary oftener than once every three years, and I beg the reader not to view its apparent high cost in too narrow a light. It is being found profitable by the largest growers, and where they lead the beginner need not—with competent advice—fear to follow.

Where, however, the procedure is considered too costly, or for any reason is not practicable, sterilization by chemicals is better than no sterilization at all. Of these, formaldehyde is now the most popular and widely used. In contrast to steaming, which need be done only every three or four years, unless new sources of infection have been introduced, such as new loam and so on, sterilizing with chemicals must be done every year.

Formaldehyde, like most chemicals of its type, is much more effective on soils of open texture than on those of heavy texture. Some difficulty is experienced with the latter in bringing the chemical in contact with every part of the soil. The procedure for using formaldehyde is as follows: 1 gallon of 40 per cent. formaldehyde is mixed with 49 gallons of water; the 50 gallons are applied to 18

square yards if the soil is fairly clean or to less down to 10 square yards for soils known to be pest- or disease-ridden. The solution is allowed to drain into the soil, which is then dug one spit deep the same day if it is not being double dug as part of the routine preparation.

Pots and boxes may be sterilized either by steam or by formaldehyde. If the example of many small nurserymen is followed and a steam sterilizer is installed for soil, and the tomato, cucumber, lettuce and other ground is sterilized with formaldehyde, the pots, boxes, canes, and the like may be cleansed in the steam sterilizer. The point is, however, that they *must* be sterilized by either one means or the other. It is foolish to spend labour and money in sterilizing soil to put it in unsterilized pots or boxes.

At the same time as the soil in the houses is sterilized the houses are washed down with a strong disinfectant such as cresylic acid. A solution is made up of 1 gallon 97–99 per cent. purity cresylic acid in which 8 lb. pure potash soft soap is dissolved by heating the mixture over a brisk fire. This is diluted with water to 40 gallons. The solution is forcibly sprayed, preferably by a mechanical sprayer, which creates a good pressure; it is forced into every nook and cranny of walls and woodwork and spaces between panes of glass. The heat should be turned on and the house closed down for several days after this treatment.

Treatment of Soil

Once a year the soil in glasshouses and frames is given a thorough overhaul. The actual time is ruled by the cropping sequence and programme. If January-planted lettuce are to be followed immediately by tomatoes, then the main preparatory work is done before the lettuce is planted. The chief items are sterilizing the soil as described above whilst double-digging it. Opinions

vary as to the value of double-digging for outdoor crops, but there is no doubt as to its value for the intensive conditions of indoor cropping.

The procedure for double digging is as follows. A trench 2 ft. 6 in. wide and one spit deep is taken out at one end of the house and for half the width of the house. The soil is placed in a heap on the other side of the path. The subsoil is broken up to a spit depth, and fertilizers and/or organic matter incorporated suitable for the crop that is to be grown. The top spit of the next 2 ft. is then thrown on to the loosened subsoil and similarly fertilized; the exposed subsoil is then loosened. This is repeated until the end of the house is reached, when the top soil from the trench taken out of the other side of the path is used to fill up the trench of the side completed. The last trench is filled with the soil taken from the first trench.

In addition to the base fertilizers supplied for the crops, it is essential that the soil contains some decaying organic matter, or else it becomes " sick " or infertile. Organic matter in the form of half-decayed manure is applied to the soil for cucumbers as part of the essential manurial preparation. Some considerable measure of success has been achieved with tomatoes by inserting straw vertically in the trenches as digging proceeds; this opens up the soil and leads to increased root action. The benefits have been particularly noticeable on soils which have grown tomatoes for several years. The method was originated at the Cheshunt Research Station, and full particulars are obtainable from the Director.

The soil in the Dutch frames is similarly treated. The work of preparation should be as thorough as in the glasshouse, for loosening of the subsoil reduces the amount of watering necessary in winter, and this is of great help, especially in lettuce cultivation.

Soil Fertility

The soil is, in a very literal sense, the nurseryman's raw material, and the maintenance of its fertility and productiveness is his chief preoccupation. Perhaps no other aspect of horticulture gives so much scope for thought and experiment as does the use of fertilizers.

Here we shall deal with the subject only in a general way. Manuring programmes for particular crops will be dealt with as we consider the crops separately. The substances used for feeding the soil fall roughly into two groups: bulky and concentrated. The former supply organic matter in addition to plant foods; the latter often supply plant foods only.

Animal manure is a bulky fertilizer which supplies both organic matter and nutrients: straw supplies organic matter, but very little nutriment; fish-meal supplies liberal quantities of nutrients and a little organic matter, sulphate of ammonia supplies an important plant nutrient —nitrogen—in liberal quantity, but no organic matter. We thus see from the above examples—which consist of one taken from large groups—that we have a very wide range of materials to choose from. It is in the *blending* of these materials that such a wide scope is offered.

We saw above, in connection with tomatoes, that soil which lacks organic matter becomes sick and incapable of producing profitable crops. This is true in greater or less degree for all crops, and the basis of any long-term manuring programme is the maintenance of the organic matter status of the soil. At one time no alternative to animal dung presented itself to the mind of the grower, and it is still widely used for certain crops. Dung, however, is not the be-all and end-all it was thought to be. For some crops organic matter is better supplied by the

relatively pure substances—peat and spent hops. Peat is especially favoured for lettuce and for tomatoes on the lighter types of soil. Its great advantages are that it persists in the soil for a long time and it is free from harmful organisms. Spent hops is much used by tomato-growers as a mulch to be dug in when the ground is being prepared for the next crops.

The organic fertilizers, such as hoof and horn, meat meal, fish meal, guanos, etc., are regularly applied every alternate year or so, oftener on the lighter soils. Their organic-matter content, though small, is of measurable usefulness, and they supply a balanced food containing the lesser-known elements as well as nitrogen, phosphates and potash. They are fairly expensive, but this must not be a deterrent. Often severe loss of crop is caused by poverty in the soil of one or more of the so-called trace elements which an occasional dressing of an organic fertilizer would have prevented. To some extent they are therefore an insurance.

The mineral fertilizers supply plant nutrients only: organic matter is either negligible or entirely absent in them. Many of them supply one nutrient only; others supply two nutrients. In purchasing mineral fertilizers and to some extent organic concentrated fertilizers regard has to be had to the analysis. The analysis of every fertilizer—straight or compound—is, by law, supplied with each consignment and also appears in quotation sheets and manufacturers' and agents' lists. The law protects the purchaser from bogus fertilizer manufacturers, and fertilizers should be purchased on analysis only. If you have any reason to doubt the quality of any fertilizer supplied a sample should be sent to the public analyst for the county in which you reside.

The mineral fertilizers are considered the principal

sources of the three key plant nutrients, nitrogen, phosphates and potash. These are expressed by the formulæ N P_2O_5 and K_2O. Their analysis, together with the analysis of the most popular organic fertilizers, is given in the accompanying table.

The steam sterilization of soil reduces the amounts of nitrogenous fertilizers required, but in certain cases increases the need for readily available phosphates and potash, the latter to check the rampant growth often noticeable in plants growing in sterilized soil.

Plant Nutrients in Fertilizers

Fertilizer.	%N.	%P_2O_5.	%K_2O.
Organic.			
Guano (Raw)	7	16	2
Fish Meal	4·5	9	5
Meat and Bone Meal	3	9	5
Hoof and Horn Meal	10	9	—
Bone Meal	3·7	20·6	—
Steamed Bone Flour	0·8	27·48	—
Mineral.			
Sulphate of Ammonia	20·6	—	—
Nitrate of Soda	15·5	—	—
Nitrate of Potash	15	—	15
Muriate of Potash	—	—	60
Sulphate of Potash	—	—	48·5
Superphosphates	—	16	—
Triple Superphosphates	—	48	—

CHAPTER VIII

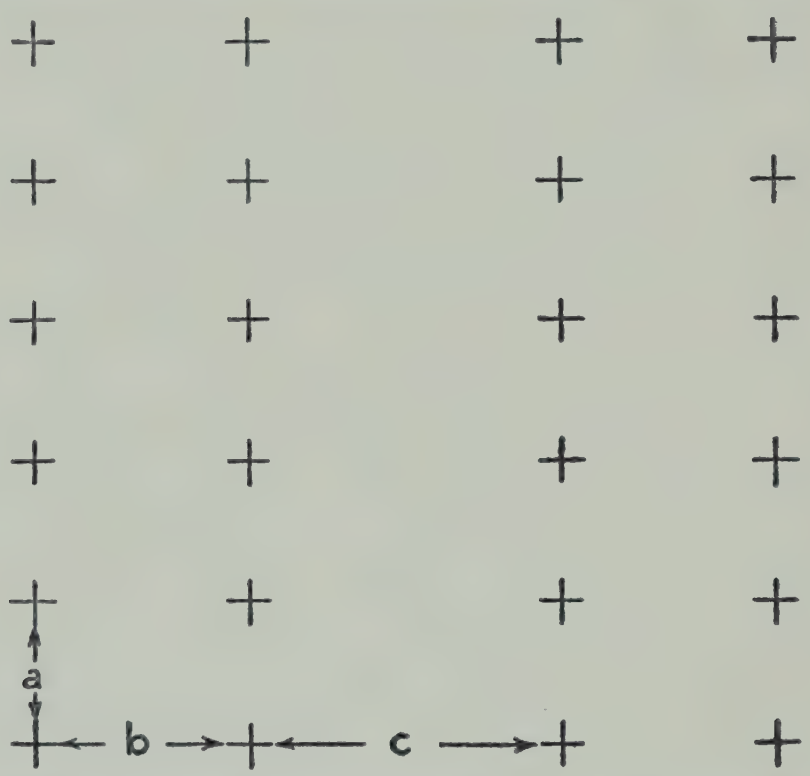
TOMATOES

Of the crops commonly grown in general nurseries, tomatoes take a high place in importance and value. Except in special areas the crop is grown to be in production from late May to August in heated houses, and from July to October in unheated houses. Attempts to obtain the crop earlier or later than these dates are generally deemed uneconomical for the general nurseryman.

During the war period the crop was grown out of doors both under cloches and unprotected, and the fruits fetched prices far beyond their real value. Whether fruits so produced will be able to compete either in price or quality with imported fruits is very doubtful. The quality and appearance of fruits grown unprotected in this country are in many seasons very poor, and few growers anticipate being able to compete with the Continental and Channel Isles growers during the glut months of August and September, when the latter send their produce to this country.

On the other hand, the produce from the British glasshouse fetches a higher price at all seasons than that of the Continental glasshouse, and the present tendency is for growers to increase their area of Dutch houses for the production of maincrop supplies, so meeting the competition of the low-quality Continental fruit with fruit of a higher quality—a policy which, if persisted in, rarely fails.

The tomato is a lover of light and air, and the houses built for the crop are always designed with these needs in mind. Winter lettuce, winter chrysanthemums and spring bulbs have the same basic needs, and a house suitable for one is generally suitable for the others. A typical early tomato house is that shown in cross-section on page 34. Such a house is also suitable for the other crops mentioned

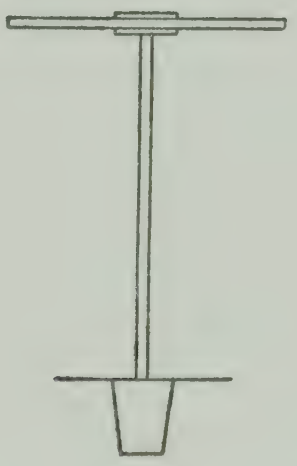


METHOD OF SETTING OUT TOMATOES IN GREENHOUSE BEDS.
a—1 ft. between plants in rows. b—18 in. between rows. c—27 in. attendant's pathway between beds.

above. In tomato-growing areas a very common size is 150 ft. long, 24 ft. to 30 ft. wide and the ridge 12 ft. to 13 ft. from the ground.

It is not generally possible to grow tomatoes, chrysanthemums and winter lettuce in one rotation, for, even if the crops could be cleared in the time, periods for soil preparation, which includes sterilization and the cleansing of

the house, must be allowed for. When the early crop of tomatoes is planted in mid-February and cleared in August, the month of September may be allocated to soil preparation and cleansing the house; the house will then be planted with lettuce in October, this crop being cleared during late December and January and, without more preparation than the incorporation of the basal dressing of fertilizer and a thorough flooding, the house will be ready for planting with tomatoes in February. The one sterilizing and cleansing will do for both the crops. If



Tool Used for Planting Tomatoes.

chrysanthemums are to precede the tomatoes, the work of soil preparation and house-cleaning will be left until the chrysanthemums are cleared, and will be done in January. If tomato planting is delayed until mid-March, then two crops of lettuce may be taken in the south: the first from an October planting, and the second from a January planting. The more laborious part of soil preparation can precede the October lettuce planting.

Maincrop tomatoes for growing in unheated Dutch houses are planted from early to late April, according to the district. They may be preceded by May Queen

lettuce planted in January and cleared in March, when the work of soil preparation and house-cleaning will follow, or the houses may be used for protecting November chrysanthemums, and the work of soil preparation and cleaning done during the winter months.

We may therefore divide the glasshouse tomatoes into three categories: (1) early, planted in February: (2) second-early, planted in March; and (3) maincrop, planted in unheated houses in April or May.

Early Tomatoes

This is the most remunerative crop. It is also the most expensive and difficult to produce. The seedlings are grown to planting-out size at a time of the year when growing conditions as regards both temperature and light are at their worst. It seems probable that eventually electricity will come to the aid of the grower in both these factors by using heating cables for raising soil temperature and low-intensity light bulbs for increasing day length and lighting under bad conditions.

Each district has its own favourite varieties for first-early crops. Kondine Red, Buckley, Tuckswood, Ailsa Craig, Riverside and ES1 all have their devotees, and the grower should ascertain which of these or other good varieties is most popular in his district.

The seed is sown about November 15th in the standard seed-boxes, which measure 14 by $8\frac{7}{8}$ by 2 in. Sterilized compost of a gritty texture, and not over-rich, should be used, and the seeds sown forty-five per box after the soil has been lightly pressed down and watered. Cover with $\frac{1}{4}$ in. of soil sifted through a $\frac{1}{2}$ in. sieve. Germinate the seeds in a day temperature of 70° Fahr., keeping them in complete darkness by covering the boxes with thick paper until the seedling appears above the soil.

When the first two pairs of rough leaves are well developed, pot off the seedlings into 60 size pots. A good compost must be used; a suitable mixture is loam 7 parts, peat 3 parts, both by loose bulk. To each bushel of mixture add 1½ oz. superphosphates (16 per cent. P_2O_5), 1½ oz. hoof and horn meal 12·75 per cent. N, ¾ oz. sulphate of potash 48·5 per cent. K_2O, and ¾ oz. ground limestone or chalk. The bulky materials should be sterilized before mixing. (There is no need to sterilize peat.) So that the materials may become "blended" together, the compost should be prepared a few weeks before it is required, and kept under a shed on a concrete floor to prevent re-infection. Two days before potting is to begin move the compost into the glasshouse to warm up, again taking precautions that it does not touch any unsterilized material.

After potting the seedlings return to a temperature of 65-70° Fahr. for two days, and damp overhead twice during the day. Then lower the temperature—particularly on dull days—to about 60° Fahr. It can rise to 70-75° by sun heat; but ventilate freely on sunny days. Try to induce a sturdy growth. When the plants have been in the pots for two or three weeks the leaves should be a deep lustrous green, the stem should be sturdy, and vigorous root-action should be evidenced by a number of fine white roots between the soil and the pot. Water each pot individually, using water sterilized with permanganate of potash and from which the chill has been taken. Remove any plants at once which show any signs of disease, also "rogues" and "jacks". The former are plants untrue to variety as shown in habit of growth, shape of leaf, etc.; the latter are plants which develop a weak, spindly stem and small leaves.

If the soil has had the thorough periodical overhaul

described in the preceding chapter for a previous crop, the work of preparing the fruiting-house will be much simplified. It will consist of applying the base dressing of fertilizers and making sure that the soil is moist throughout its depth. A usual dressing of fertilizers is 7 cwt. hoof and horn, 7 cwt. sulphate of potash, $3\frac{1}{2}$ cwt. bone-meal, $3\frac{1}{2}$ cwt. bone-flour, all per acre. On virgin soil the hoof and horn is often omitted and the quantities of bone-meal and bone-flour doubled. Work the fertilizers into the top 9 inches of soil. It is desirable that the soil contain sufficient moisture at planting time to last the plants four to six weeks, but judgment must be exercised how much water is given: a light loam on gravel can be given a much greater quantity than a loam overlaying clay. Watering should be completed a week before planting, and the soil left undisturbed to warm through.

Soil temperature is known to be a vital factor in tomato cultivation. A temperature of 57° Fahr. is generally considered the lowest at which it is safe to plant tomatoes, and higher soil temperatures up to 80° Fahr. have been found to produce up to 30 per cent. increase in crop.

The plants are put out in beds, the dimensions of which are shown on page 66. This arrangement enables every plant to receive attention easily and conveniently. It is time-saving to make three laths with measuring marks permanently cut or burned in them; two will have marks alternately at 18 in. and 27 in. and will be used to indicate the position of the rows, and the other will have marks 12 in. apart and will be used to indicate the position of the plants in the rows. The holes are made by a heavy iron dibber with a blunt end exactly the same shape as a 60 size pot and a circular flange to prevent it entering the soil below the required depth. The dibber is thrust into the soil with a single forceful thrust and given a half-turn;

this leaves a clean hole, into which the plant exactly fits.

Half an hour before planting the pots must be thoroughly watered, so that the ball of soil is soaked and the plants knock out easily. The plant is pressed gently and firmly into the hole, and this completes the operation. If the holes have been properly made the level of the ball should be level with the soil surface.

As has been said, the soil should not need watering for some time after planting, but a light overhead sprinkling helps the plants on bright days, but it should be done sufficiently early in the day so that the leaves are dry by nightfall. It is often necessary to water balls of soil of the plants once or twice after planting until active growth shows that the roots have entered the soil of the bed.

The plants will require support; this is usually effected by strings of four-ply fillis attached at their lower ends to pegs formed of $\frac{3}{16}$-in. wire about 30 in. long, and at their upper ends to 12- or 14-gauge wires stretched between timbers secured at each end of the house and supported at intervals by cross-supports secured to the purlin posts. The wires at the sides of the house are supported by wires looped through holes bored in the glazing bars, so arranged that no bar supports more than two wires. Bamboo canes are rarely used nowadays for supporting tomatoes. The tale is told of one grower who burnt the whole of his stock of 100,000 canes on one glorious bonfire after he had become convinced that they were purveyors and perpetuators of pests and diseases. The plants are supported by twisting the string round the stem so that the string resembles a runner-bean plant climbing its rod, the tomato plant forming the rod.

The plants are usually grown with a single stem, and the lateral shoots which appear in the axils of the leaves are

rubbed out whilst quite small. Sometimes one side-shoot is allowed to develop, but this introduces dangers of disease, especially for the beginner.

As the plants develop, judicious defoliation must be carried out, beginning with the entire removal of the bottom leaves when the first fruits are swelling nicely. Afterwards sufficient leaves are removed to ensure a free circulation of air between the plants. This is absolutely essential, but it must be carried out with care if fruiting propensities are not to be impaired. A whole leaf should be removed from each plant at strategic points and places where the desired object will be achieved by its removal.

Whilst a free circulation of air is essential for reasons of health, some moisture in the atmosphere is necessary to secure pollination and fertilization of the flowers which is the essential prelude to fruit-formation. Damping down is an important part of the daily routine, and is done in the morning, spraying the plants with clear water. Faulty pollination can, however, be caused by too low night temperature and too low soil temperature. Neither should be more than a degree or two below 60° Fahr. A too dry soil is also very unfavourable to good development of the flowers. The petals should always be a bright yellow and the stalk green and plump.

The condition of the flowers will indicate when the first real watering becomes necessary. So long as the flowers are of a full deep colour and the stem is plump and green all is well. A developing lack of colour in the flower and a greying of the stem indicate that water is needed, and sufficient should be given to moisten the soil.

The quantity will vary with the type and texture of the soil; a cane thrust into the beds at intervals will show when the soil is moist throughout its depth.

With the appearance of the third truss and when the

fruits of the first truss are swelling nicely a tomato fertilizer may be applied. A common mixture is sulphate of ammonia 3 parts, dried blood 2 parts, superphosphate (16 per cent. P_2O_5) 7 parts, pure dissolved bones 5 parts, bone flour $\frac{1}{2}$ part, sulphate of potash $2\frac{1}{2}$ parts, all by weight, and the mixture applied at the rate of 5 cwt. per acre. But there are no rule-of-thumb methods of feeding tomatoes. The successful grower studies his plants and varies his feeding routine with their needs and the state of the weather.

Subsequent top-dressings are given at intervals of fourteen–twenty-one days, but the mixtures vary, especially as to nitrogen content, for an over-flush growth must be avoided. Each dressing generally includes sulphate or nitrate of potash (the latter supplies nitrogen in a readily absorbed form) and phosphates to maintain vigorous root action and fruit formation. When frequent watering becomes necessary a mulch of peat, hops or straw is useful in preventing the soil becoming packed down and the surface sealed up and checking the entry and exit of air from the soil-body.

Little stopping of the leading shoot is practised nowadays, though at one time many growers stopped the plants at the fourth or fifth truss with the idea of hastening the swelling of these fruits and continuing the upward growth of the plant by allowing a side-shoot to develop. This, however, is not extensively practised now. Usually the plants are allowed to continue their growth naturally until the top of the wires is reached. The point is then taken out two leaves beyond the last truss.

Second Early Tomatoes

The second early sowing—which for many growers in a small way is the only sowing—is usually made just before

or just after Christmas. The plants come ready for planting out in early March, which permits a crop of lettuce to be taken. The same remarks as to varieties and general growing routine apply to this crop as for the earlier crop, and little can be added. Usually the plants grow steadily throughout the period, and one has not to fight the bad light and atmospheric conditions with this, as with the earlier-sown crop.

Maincrop Tomatoes for Cold Houses

As has been said, growers are looking to meet the competition of Continental produce more and more with fruits grown in cold Dutch houses. Their experience has been that people are willing to pay the little extra for English glasshouse tomatoes which have been properly graded and marketed.

The date for this sowing is ruled very much by district. About mid-February is a popular time in the south, where the plants can be put out with safety in early April. In more northerly districts the first week in March is soon enough. This provides plants ready for planting out about the third week in April, which is soon enough for cold house conditions.

Heavy cropping and robust varieties are chosen for this sowing, such as Ailsa Craig, ES1, Radio and Market King, all popular in districts which suit them. The same remarks as to general cultivation are applicable to maincrop as to the earlier crops. The grower, being entirely dependent on sun heat, must learn how to conserve this to the best advantage, and watering in the early stages calls for some skill and judgment if chilling of the soil is to be avoided. Coldness of soil is the great enemy of the tomato in cold houses, and it is likely that some measures of economic soil heating will prove of great value in this crop.

Picking and Marketing

The time of picking varies according to whether the fruits are to travel a distance or whether the market is close at hand. In the former case the fruits are picked two days or so before they become fully coloured; in the latter they are allowed to become fully coloured.

It is likely that the National Mark Scheme for grading all horticultural produce will be revived, and the grower should pack his best produce to conform with the requirements of the scheme—or, at least, such produce as he sends to the market. Fruit which does not come up to National Mark requirements is marketed as " seconds " or " thirds " at a proportionately lower price. Tomatoes are packed in returnable boxes containing 20 lb. or non-returnable boxes containing 12 lb.

CHAPTER IX

CUCUMBERS

So far as importance is concerned, cucumbers rank only a very little way behind tomatoes. Here, however, the similarity ends, for the cultural routine for the two crops is entirely different. The houses in which cucumbers are grown are much smaller than those intended for tomatoes, and inasmuch as a high temperature has to be maintained at all times, conservation of heat is a factor in their design. A typical cucumber house is the smaller house shown on page 34. They are 14 ft. wide, with sides of $4\frac{1}{2}$-in. brick wall carried to the eaves-plate, which should not be more than 4 ft. from the ground. The height is 5 ft. greater than the height to the eaves—in this case 9 ft. Ventilators are provided on both sides of the roof, but there is none in the side walls. Two flows and two returns provide the heating installation. These are sufficient for average conditions, but on very exposed sites it may be necessary to increase the pipe area.

In the small general nursery the cucumber houses will also be used for other purposes: for forcing flowers, for propagating and so on. The cross-partition proves its worth in such cases. The smaller of the two may be used for an early crop of cucumbers, and the larger house for the main crop when propagating and forcing are over for the season. The first crop will be planted in January, the seeds being sown in December, and the main crop planted in March from seeds sown in February.

Varieties. The number of first-class commercial varieties

is relatively few. Butcher's Disease Resister is probably the most popular and the best for the beginner. A very early variety is The Worthing; this is most suited to the sunny districts from whence it takes its name. Chennel's Challenger is a good maincrop. Varieties such as Improved Telegraph and its type are not much grown in commercial nurseries.

Sowing the Seeds

The first crop is sown about the first week in December. A propagating frame is made up in the warmest part of the propagating house. This may consist of a cheap two-light frame 6 ft. long by 4 ft. wide. A layer of peat 6 in. thick is put in the bottom after being thoroughly moistened. The pots in which the seeds are sown will be plunged in the peat to their rims. This should be done some days in advance of sowing, so that all may be nice and warm in readiness. The temperature in the frame should be 65° Fahr. on normal nights and never fall below 60° on the coldest nights. Day temperatures may rise 10° higher.

The soil for the seed-pots—small 60's or 2½-in.—should consist of 2 parts good loam and 1 part well-decayed horse manure, with a 60 size potful of bone-flour and lime to each barrow-load of compost. It should be mixed and sterilized some time before it is required, and protected in the meanwhile from reinfection. In estimating the number of plants required, it may be calculated from the distance apart they will be planted, which is 30 in. Thus the smaller of the forcing-houses will hold about forty plants; the larger house will take about seventy-two.

The pots are carefully prepared with some rough (sterilized) material over the drainage holes, and then filled to within ½ in. of the rim after the compost has been lightly pressed down with the fingers. The seeds are

placed singly on the surface, making sure that only plump, firm seeds are sown, and covered with ¼ in. of compost. The pots are placed in the frame; the frame is then syringed with tepid water and the lights are closed down tight.

Under suitable conditions the seeds germinate very quickly. In forty-eight hours or less the seedlings will be pushing through the soil. As soon as the seed-leaves are well expanded the plants should be taken out of the frame and stood on the staging. A similar procedure is adopted for later sowings, except that as the nights become warmer the propagating frame may be dispensed with and the pots simply covered with sheets of glass and paper.

Growing on the Plants

Young cucumber plants grow very rapidly in congenial conditions and soon they will require potting on into 48's. In no circumstances must they be allowed to become starved through pot-bind. A moist, warm atmosphere, with a day temperature of about 75° Fahr. and a night temperature of 60–65° Fahr., should be maintained, and the plants damped over twice a day, or oftener on bright days. The move into 48's may be followed by one more move into 32's. Each plant will now require a 2-ft. cane to support the lengthening stem. The compost used for these moves will be as for the seed-pots, but may be of somewhat rougher texture. Make sure that it is " free " and open. Watering must be conscientiously attended to, using tepid water of the same temperature as the house. Remove all tendrils and flowers as they appear.

Making up the Beds

A week before the plants are to be put out the beds should be made up. The borders will have been dug and

sterilized some time in advance, and the beds are made up on these. The compost consists of 2 parts new loam to 1 part strawy horse manure. Unless there is reason to suppose that the loam is infected there is no need to sterilize these materials. The loam should, however, have been stacked for six months or more before it is required. No attempt should be made to reduce it to a fine condition. It should be chopped down with the spade, and for each barrow-load of loam and manure 1 lb. of bone-flour and 1 lb. of lime should be added to the mixture. Allow one barrow-load of mixed compost for each yard run of bed. The beds should be made up to the walls and be about 20 in. wide at the base, 15 in. wide at the top and 10 in. high. Do not bring the beds to a point, or it will be impossible to water them. The top should be flat. Gently firm the compost without making it in the least degree solid. The house should then be heated for a week to bring the soil to the same temperature as the house, and a thermometer should be used to ensure that the soil is thoroughly warmed through before the plants are put in.

Planting

The beds having warmed through, the plants may be put in. Some hours before planting give the plants a thorough watering. Plant $2\frac{1}{2}$ ft. apart and about 9 in. away from the wall. Give the bed a good watering; this will last for four or five days.

The plants are trained on wires arranged to form 10-in. squares and about a foot from the glass. The horizontal wires are strained from timber or metal bars secured to the ends of the house, and are supported intermediately by wires suspended from the glazing bars. The oblique wires—that is, the wires running from eaves to roof—are

fastened to the horizontal wires by a single twist of wire. Fourteen-gauge wire is used for all. Some modern cucumber houses are equipped with a subsidiary iron framework for taking the weight of the wires and crop so that no strain is put on the roof. The bottom wire comes to within 2 ft. of the bed, and the plant is led to this up a bamboo cane. The main stem is taken up the back of the wires and loosely fastened with soft raffia as it grows. It is not stopped until it has reached the ridge. The side-shoots are tied loosely to the nearest wire, and the laterals similarly. These will produce female flowers, and the laterals are stopped two leaves beyond each such.

Female flowers are easily recognised by having an embryo fruit behind the flower, whereas the male flower has no fruit. All male flowers, together with tendrils, are removed as soon as they appear. Sub-laterals are similarly stopped at one leaf. This is vital for the development of the fruit and the continual production of young growth. Flowers forming on other parts of the plant than the laterals should be removed.

Watering

This calls for considerable care. The bed must be kept moist but must never be allowed to become water-logged. If in doubt whether or not water is necessary, thrust a cane into the bed and note if moist particles adhere when it is withdrawn. The atmosphere must be kept in a very moist condition, and damping down must be done as often as necessary, which will vary with the weather.

The water used both for watering and damping must be at the same temperature as the house, and the water-tank capacity should be sufficient for this. For a house with thirty or so plants two 50-gallon casks will suffice; they may for convenience be placed at each end of the

house. As the sun becomes hot it will be necessary to lightly shade the house with " Summer Cloud " or very thin limewash. Ventilation should be given when the temperature rises about 80° Fahr.

Cucumber plants grow very rapidly, and need a continual supply of nourishment. When fine white roots appear on the surface the beds should be top-dressed with 2 or 3 in. of compost, and this must be repeated as frequently as is necessary. Feeding also with a nitrogenous fertilizer, such as blood-manure, guano, and so on, may commence when the fruits begin to form. A mulch of good horse-manure will help the plants when they are beginning to age, but care must be taken that the manure has lost its " fire " before it is taken into the house, or the plants will be badly scorched by the fumes.

Packing and Marketing

The fruits are cut when 12–15 in. long and packed in boxes called " flats ", each of which holds 36 lb. of fruits, or in half flats which will contain fifteen to thirty fruits, according to their weight. Some of the most progressive growers have sought to give their produce an added attraction by packing each separately in a cellophane tube. This has not been possible during the war, but the practice is worth reviving, as is anything that makes the produce of the English nursery more attractive to the buying public. But the contents should be worthy of their packing, and only top-grade fruits should be so distinguished.

CHAPTER X

LETTUCE

From being the speciality of a few growers lettuce is now one of the key crops of the general nursery, particularly winter and spring supplies.

The crop may be conveniently divided into four categories; winter glasshouse, spring glasshouse, spring outdoors, and summer.

Winter Glasshouse Lettuce

This crop is usually a catch-crop between two crops of tomatoes. In the south the first crop occupies the ground roughly from the first week in October to the last week in December, and the second crop from mid-October to mid-February. Both are thus very useful for following tomatoes, the first crop following straight after early tomatoes, and the ground prepared for tomatoes again when the lettuce is cleared, the second crop also following early tomatoes, but with the major preparative operation for the following season's tomatoes preceding the planting of the lettuce.

A suitable variety for the first crop is Cheshunt Early Giant. Seeds of this are sown about September 15th, and the seedlings pricked out into nursery boxes ten days or so later. The soil for the beds should be prepared by forking over to loosen the soil and incorporating some moisture-holding material such as good-quality peat. The basal dressing for the tomatoes given on page 70 may be applied; this will serve both lettuce and tomatoes, or

the crop may be grown on the residues left by the previous crop of tomatoes with the addition of 1 cwt. sulphate of ammonia, 4 cwt. superphosphate and 1 cwt. of sulphate of potash per acre. If this mixture is applied the superphosphates given in the basal dressing for the tomatoes may be reduced. Should any reason exist to suspect botrytis the soil should be sterilized with formaldehyde as described on page 59. If this is to be done the soil should be allowed to stand for several days after the sterilizer has been applied, until all smell of the chemical has gone, before the plants are put out.

Sufficient water must be given before planting to ensure that the soil is nicely moist throughout its depth, as it is not desirable to water the crop any oftener than is absolutely necessary.

Cheshunt Giant is planted 9 in. apart in rows 10 in. apart. Every fifth row should be missed, to give access to the plants for watering, cutting, etc. The plants are dibbled in by hand, care being taken not to plant too deeply: the crown should be above soil level and the soil finished off smooth round the plants. The plants are settled in with a little water, and no more is given for at least a fortnight.

The most favourable temperature for lettuce is 50° Fahr. by day and night. It may rise to 55° Fahr. during the daytime with sun heat, but it should not fall much below 50° Fahr. at any time.

Ventilation should be afforded whenever outside conditions make it possible. Watering needs to be carried out with great care. Apply the water gently through a $\frac{1}{2}$-in. hose pipe held close to the ground. The intervals between watering will vary with the texture of the soil. On average soils about once a week is sufficient when the crop commences free growth after planting out.

The second crop is sown about October 3rd and treated similarly.

Spring Supplies from Glasshouse and Frame

Spring supplies—that is, during March and April—are obtained from January-raised plants of Cheshunt Early Giant or from October-sown plants of Gotte-a-forcer. In the former case the routine is as described above for early lettuce, and the crop is followed at once with tomatoes. In the latter case the seeds are sown in cool conditions about October 10th, and pricked out into nursery boxes, which are likewise kept in an unheated frame. The seedlings are transferred to heated beds under Dutch lights in January. At one time the heated bed consisted of fermenting horse manure, but the increasing scarcity of horses renders that method more and more impracticable. Hot-water pipes have been tried with a fair measure of success, but the cost of installing and heating the pipes is high in proportion to the return.

A great deal of valuable work on the use of low-voltage heating cables for hot beds has been done, and it seems likely that this may provide a solution. Albeit, the incorporation of some readily decomposable organic matter is desirable for closed-frame culture, if not to supply heat, then to supply carbon dioxide—an essential nutrient in plant-growth—which, with plants growing in the open air or in the airy conditions of a glasshouse, is obtained in sufficient quantity from the atmosphere.

Dutch frames are now used almost exclusively for this crop. They provide the condition of abundant light so necessary for lettuce The frames are made up in November and left open, so that the soil becomes thoroughly soaked through. Manure is freely incorporated with the soil to promote rapid growth and retain

moisture. No "artificials" are applied. Early in January the heat is turned on, and after the soil temperature has risen to about 45° Fahr. the plants are put in, the lights returned to position, and the crop is left to mature more or less untended.

As it is not desirable to water this crop any more than is absolutely necessary, capillary rise of water from the subsoil is induced by loosening the subsoil when preparing the beds, and the lights are kept closed whilst the crop is growing, thus checking losses of water vapour to the outside atmosphere. If, however, watering does become necessary, then apply it gently between the plants and not overhead.

Spring Lettuce Out-Doors

On light soils and in localities where frosts are not too severe hardy varieties of lettuce are sown in seed-beds in August or September, the plants transferred to beds in November, being set 9 in. apart each way. Here the plants remain all winter, and heart up in spring. Imperial and Winterongs are among the most popular varieties for this sowing. The necessity for hardiness in the plants implies a somewhat coarse texture, and these lettuce are not so popular with the public as glasshouse or frame lettuce. Cloches are of value in preserving them from excessive wet.

Some improvement in quality is secured by dressing the plants in spring with a good Peruvian guano or a quick-acting nitrogenous fertilizer.

In many districts a more saleable lettuce for April and early May is secured by sowing Golden Ball or May Queen in early February and planting out in Dutch houses. If the soil has been prepared for the tomatoes no fertilizers other than those applied in the tomato-base fertilizer will

be necessary, and if the lettuce are planted somewhat late they may be so spaced that the tomatoes can be planted before the lettuce are cleared. Both the varieties mentioned produce hearts of high quality, and the procedure outlined offers a greater attraction to many growers than that of hardy lettuce. Dutch frames are also eminently suitable for April lettuce.

Summer Lettuce

Unless a continual demand for a particular market has to be maintained the general nurseryman in a small way usually leaves summer lettuce to his market-gardening brethren. The summer crop has to be grown on mass-production lines to be remunerative, and even then the prices are sometimes so poor in glut seasons that acres of fine produce is ploughed under. But where a local demand exists the summer crop can be grown if land can be spared.

For May and June cutting, seed of May Queen, Feltham King, or Early Market All Heart is sown in frames in February and the seedlings planted out in late March. The ground is deeply stirred and a dressing given of hoof and horn 8 cwt., superphosphate 3 cwt. and sulphate of potash 2 cwt. per acre. The plants are dibbled in 9 in. apart each way. Ground rich in organic matter is desirable, and this crop best follows one which received a fairly heavy dressing of dung. If lime has not been applied recently it should be given for this crop.

For successional supplies seeds are sown out of doors from March onwards in drills 1 ft. apart and the seedlings thinned to 1 ft. when they are large enough to handle.

Varieties chosen for these outdoor sowings are usually such as can resist drought, though growers who specialize in high-quality lettuce are now installing irrigation

equipment in increasing numbers. All the Year Round, Dry-weather, Market Favourite, Feltham King, Webb's Wonderful and Sutton's Favourite are a few of several popular varieties for these sowings. The sowings usually cease in late June.

Cutting and Marketing Lettuce

It is likely that the competition among growers for the best markets for lettuce is likely to grow greater rather than less, and only the best produce will earn a profit. Cutting and packing, no less than growing, require close attention. Only hearted lettuce is required in any quantity. The hearts are cut early in the day whilst the leaves are turgid with sap. Discoloured leaves and protruding stumps are cut off, the heads washed and packed heart downwards, a dozen in a box lined with grease-proof paper.

The National Mark Scheme prescribes the minimum weight of each heart, the degree of freshness, and method of packing for produce which is entitled to be sold under the mark. The grower should take these as the minimum requirements, and should endeavour to improve upon them. A reputation for " quality " produce is his most valuable asset.

CHAPTER XI

OTHER SALAD CROPS

WHILST lettuce is the most important of the crops grown for salad, in the items which accompany lettuce the nurseryman finds several profitable sidelines. The chief of these are radishes, mustard and cress and "spring" onions; endive, chicory, corn salad and dandelion are also grown, but on a very limited scale, and the beginner had best leave these to the specialist who knows when and where the demand exists.

RADISHES

This crop is most popular and remunerative in the spring. Summer supplies come mainly from large market-gardens, when they are poured on the market in such quantities as to force down the price to a level that is unattractive to the general nurseryman.

In a few favoured parts of the country and by a special routine radishes for spring may be grown out of doors. But the bulk of the supplies are grown in glasshouses or cold frames. It is useless attempting to produce the crop too early, as the formation of the swollen root is dependent on a fair amount of light. Dutch houses and frames are very suitable, and it is not necessary for either to be heated, though earlier crops are obtained by maintaining a temperature of 55° Fahr.

The public taste decrees the varieties. The most popular are those with neat, shapely roots of a bright scarlet colour. Glowing Ball Forcing, Forcing Scarlet Turnip and Red Turnip Short Top Forcing are all suitable.

The crop is regarded as a catch-crop when grown in glasshouses. From sowing to pulling the first roots is about six weeks, and pulling usually extends over about two weeks. Thus if a house is cleared of late chrysanthemums in December and is not to be planted with tomatoes until April there is time to prepare for the tomatoes and take a crop of radishes.

A fertile soil well charged with moisture-holding organic matter is necessary, for the roots must grow quickly if they are to be palatable. A fine, firm surface tilth is produced and the seeds are sown very thinly and covered with ¼ in. of soil. If the soil is at all dry it should be well watered. Afterwards it is maintained in a nicely moist condition by overhead sprinkling, the frequency of this varying with the season. If the seed has been sown too thickly, some thinning will be necessary, but this is a sign of unskilful work. The plants should stand about 3 in. apart.

Cultivation in frames is very similar. A dressing of some organic fertilizer, such as meat- and bone-meal or fish-meal, is necessary if the soil lacks nutrients. Sometimes lettuce and radishes are grown together, but this dual cropping implies skill and experience which the tyro cannot be expected to possess. He is likely to finish by having neither crop in the condition needed for marketing.

Radishes are marketed in bunches of from six to twelve or more roots, according to the time of year. The leaves are left on. The bunches are secured by a double twist of raffia, the roots washed, and the bunches packed two to three dozen in paper-lined boxes.

Mustard and Cress

Mustard and cress is in demand all the year round. To the nurseryman it provides an attractive crop for the winter months when houses are standing empty. It must

not, however, be regarded as a crop that can be grown anyhow. A first-class sample, well grown and attractively packed, is a product of professional skill.

Cucumber or forcing-houses are generally used for the crop. A temperature of 55–60° Fahr. is needed to produce the long, tender stems which a good sample possesses. Two methods are in vogue: growing the crop on old cucumber beds and growing in shallow boxes. In the former instance the produce is marketed in punnets—small square chip baskets—in the latter case the entire box is sold to the retailer when the stems are of a size for cutting. The first method is the most popular.

The soil is dug over, levelled, reduced to a fine tilth, and then beaten firm with a spade. When ready for sowing the bed should be as level and flat as the proverbial billiard table. It is then watered through a fine rose and the seed sown thickly, so that a dense carpet of growth is produced. Do not water the seeds after sowing, as this causes them to " mat " together. The seeds are covered only with hessian sacking, which is kept moist by occasionally damping. This is continued until the stems are about 2 in. long. The crop is ready for cutting about forty-eight hours later, when the seed-leaves have turned green. Sometimes rape is sown instead of mustard.

The crop is taken by cutting with a very sharp, long-bladed knife; a handful is held in one hand and the stems cut close to the ground. No roots or dirt must find their way into the punnets. Sometimes the mustard and cress are mixed; sometimes they are packed separately. The wishes of the buyer should be ascertained on this point. The punnets are packed in wooden boxes for the market.

When the crop has been cleared the top inch is peeled off. This removes the roots and " stubble ". The soil is

then prepared for another sowing. In this way several crops are taken during the winter.

"Spring" Onions

Large quantities of "spring" onions are raised and sold by the market-gardeners, but these are mainly from the open ground and are on sale from April onwards. The early spring supplies are the province of the nurseryman, to whom, if the produce is offered in an attractive way, the crop is a lucrative sideline.

Seeds of a popular variety, such as Ailsa Craig, Giant Rocca, Bedfordshire Champion or White Spanish, are sown in early August in ground which is occupied by or can be covered with Dutch frames or cloches. Drills 6 in. apart and 1 in. deep are drawn in fertile soil made fairly firm and the seeds scattered evenly along them. If the crop follows lettuce or some crop for which fertilizers were given, no further fertilizers are necessary at sowing time.

The crop is kept clean until December, when the lights are placed in position.

About the end of January an application of a quick-acting nitrogenous fertilizer such as nitrate of soda is watered in. Pulling commences from the end of February onwards. The stems and roots are washed clean and bunched neatly from six to a dozen in a bunch.

CHAPTER XII

FORCED RHUBARB

The production of forced rhubarb is attractive to the general nurseryman who has sufficient ground to allot to the nursery beds. Where ground is limited, however, one may justifiably ask if so much space can be locked up with one crop. For the crop to be a worth-while proposition at least a quarter of an acre should be allotted to it. This will hold about 1800 plants spaced 2 ft. by 3 ft.; one third, or 600 plants, will be available for forcing each year if necessary, or 500 may be forced and the rest split up to grow on to forcing size.

Rhubarb needs a deep fertile soil—one which is well drained and holds moisture well. Heavy clays and thin sands are alike unsuitable for producing forcing stools.

The type of stool needed for forcing is one with well-developed fleshy roots and five or more crowns or buds. Such are produced by good cultivation in three years from planting sets, which are single crowns. The area is therefore divided into three sections—first year, second year, and third year. Rhubarb must not, however, be grown on the same ground year after year. It should have at least one year's rest, during which some other crop may occupy the site. This means that an area equal to that occupied by one year's clumps will be technically assigned to the rhubarb, but will be " resting ". As has been said, this does not prevent the land being used for some other useful crop.

Varieties. The most popular varieties for forcing are

Prince Albert and The Sutton and Victoria. The first-named is the earliest.

Planting Rhubarb

The land is prepared by ploughing and digging and subsoiling, incorporating a dressing of farmyard manure. This is done in early autumn, so that the land has time to settle by November. Sets consisting of single strong crowns should be procured from a reputable source and planted in November 2 ft. apart in rows 3 ft. apart. The top of the crown should be level with the soil surface. If planting cannot be done in November it is best left until February.

In the following spring a dressing of sulphate of ammonia, 2 cwt. per acre, should be given, followed by a dressing of farmyard manure in the late winter or early spring of the second year. If manure is difficult to obtain, 8 cwt. basic slag and 4 cwt. of kainit may be applied in autumn, followed by 2 cwt. sulphate of ammonia the following spring. Dried sewage sludge is also valuable as a top dressing.

If vigorous roots of forcing size are to be built up in three years from planting crowns no stalks should be pulled during that time, as the full complement of leaves is essential for the elaboration of the reserve materials on which the plants will draw when being forced. The beds should be lightly forked through in early winter and weeds kept down during their growing period; flower-stalks should be cut off as they form, care being taken to inflict the minimum of damage on the leaves of the crop.

Forcing the Crop

An excessive temperature for forcing is not necessary or desirable. Such temperatures as are maintained during

winter for pot plants are quite suitable. It may begin at about 45° Fahr. when the roots are first put in and be gradually increased to 60° Fahr. when growth is well under way. It should not exceed the latter temperature, or the colour and texture of the sticks will be adversely affected. Absolute darkness is desirable. If an ordinary glasshouse is to be used darkness may be obtained by making light shutters with 2 in. by 1 in. wood on which thick brown paper is tacked; with care these will last for several years. In planning the area 1 sq. ft. should be allowed for each root.

To extend the supply, and to prevent too much room being taken up by the crop in the houses, the 500 roots may be forced in two batches of 250 each. The first will be put in in late November and the crop will come in for the New Year; the second will be brought in in late January and will be pulled in late February and March.

The roots should be dug up carefully with a strong four-tined fork, and left to lie on the surface until they have endured one frost; this makes them respond much more readily and quickly to heat. They should then be packed carefully into the forcing space. Fine soil should then be worked between the roots and brought level to the surface of, but not burying, the crowns.

Watering should be attended to once or twice a week, according to the weather and temperature. The shutters may with advantage be removed at night when darkness has fallen, but they must be replaced before dawn. If a crop of the finest quality and most attractive appearance is to be obtained, watering and pulling should be done at night by candle-light, for very brief exposure to daylight is sufficient to cause development of green in the leaves and spoil the appearance of the sample.

The stems are pulled when about 12 to 15 in. long;

the leaves are left on, but the bases are trimmed a little. They are made up into bunches of from two to six or more sticks, according to the season. The bunches are secured with raffia or sometimes with rubber bands, and packed in six dozen bunches in paper-lined wooden boxes.

After forcing, the roots are discarded. It is wisest to burn them, but if healthy they may be stacked and allowed to rot down for compost to be applied to other parts of the ground than the rhubarb bed.

CHAPTER XIII

RAISING PLANTS FOR SALE

One of the most profitable lines for the general nurseryman is the raising of plants of various kinds for the amateur gardener. A seasonal demand exists for many different kinds of plants; tomatoes, vegetable plants, bedding plants, all are raised and sold by the million each year to amateurs.

The nurseryman may approach this market from two angles. He may seek to exploit the ignorance of the amateur and make his profits by selling badly grown plants at a cut price, or he can take a pride in the plants he offers and refuse to sell a plant which he would not put out in his own nursery. There is a market for both, and probably always will be. But one has to remember that only one standard can prevail through all one's work. That is to say, all one's work is good or it is all bad. Whether the reader dare risk lowering his standard by producing badly grown plants is a question for him to decide. In this chapter I shall presume that he cannot, and my suggestions will be for the production of good-quality plants which will satisfy the purchaser and enhance the seller's reputation.

Vegetables

Tomato Plants. The demand for these is first, for plants to put out in cold houses in late April or early May. The varieties should be popular and easily grown, such as Sunrise, Market King, E.S.1, Best of All, and so on. The seed is sown in late February, and the plants

grown on to a hardy condition in which they may with safety be put into cold houses. They are sold in size 60 pots. A demand will continue doubtless for tomatoes for outdoor cultivation. These need to be ready for sale by the last week in May, and are sown about the first week in April.

The plants will grow throughout on the temporary staging in one of the growing-houses. For raising the plants the same cultural routine given in the chapter on tomatoes should be followed; sterilized soil and pots should be used.

Cucumbers. There is often a limited but useful call for cucumber plants for cool houses and frame culture. The best varieties for the amateur are Every-day for heated houses and Challenger for unheated houses and frames. Neither is likely to be required much before the middle of May, and seeds sown in mid-April will produce plants of the right type for sale in 48 pots. They may be raised in the forcing-houses but transferred to cooler conditions a week or so prior to being offered for sale.

Lettuce. The only time of the year when the demand for lettuce plants justifies attempts to meet it is during March and April. Seeds of a variety which is fairly early and which will stand transplanting, such as Golden Ball or May Queen, may be sown under the Dutch lights in early March and the seedlings pricked out 2 in. apart each way on one of the sheltered borders where they will appear attractive for sale.

Onions. There is a brisk demand for January-sown onion plants in March and April for planting out on allotments and in private gardens. This mode of cultivation suits the needs of many amateurs far better than March sowing in beds. A good strain of Ailsa Craig is the most suitable. The seeds are sown under Dutch lights the first

week in January. Better and more forward plants are obtained if the soil is heated, and this may prove a suitable exploitation of soil heating by electric cable. The seeds are sown very thinly in drills 6 in. apart in good soil; the rows are kept clean, but no other cultivation is necessary.

The plants are lifted very carefully with a hand-fork, and the soil shaken off the roots. Usually each customer's order is dealt with when the customer is ready to plant them, so that the plants are not out of the ground any longer than is necessary. Some customers are willing to pay extra for plants which have been pricked out into nursery boxes, and if room is available a hundred or so boxes may be pricked out; but the nurseryman must be sure that he will be able to obtain a price which compensates him for the time, materials and space taken up.

Brassica Plants. These include all kinds of greenstuff. The trade may begin in April or early May with cabbages and cauliflowers sown in Dutch frames in February. There is always a heavier demand for cabbages after a hard winter, when many of the autumn-planted crop have been lost. An early cabbage should be sown, such as Velocity or Earliest of All. For cauliflower, Early London and Snowball are reliable. In March and April breadths of all kinds of winter greenstuff should be sown in drills 1 foot apart. The Brussels sprouts should be put in first, followed by autumn cabbage, savoys, kales, sprouting broccoli and a few cauliflower-headed broccoli.

A Planet-type drill is immensely useful for sowing seeds in the open ground. Machines are obtainable which sow all kinds of seeds, from brassicas to peas, and it is possible to sow seeds very thinly with them—far more evenly and thinly than by hand. These plants will be pulled and sold straight out of the seed rows. Give the land a good dressing of lime before sowing.

Suitable varieties are: Brussels sprouts, Harrisons XXX, Evesham Special; Cabbage, Primo, Winningstadt; Savoy, Sutton's New Year and Rearguard; Kale, Cottagers and Scotch Curled; Sprouting Broccoli, Purple and White; Cauliflower-headed Broccoli, Michaelmas White, Autumn Giant, January King, Snows Winter White, Leamington, Whitsuntide. Buy seeds of first-class strains from reputable firms. There is much worthless brassica seed on the market.

Celery. The trade for celery plants is fairly certain, as only those amateurs with greenhouses can raise their own plants. The white varieties are generally the most popular, and a good strain of Solid White is likely to suffice. If it is desired to be able to offer red as well, Standard Bearer and Major Clarke's Red are good. The plants are required in May. The seeds should be sown in early March in one of the growing-houses, and the seedlings pricked out on to old cucumber-bed soil which has been sterilized and sifted, and grown on to selling size in Dutch frames. Better plants with less labour of watering are obtained by this means than by growing in boxes.

Leeks. These also usually sell quite well. For plants for early sale sow with the onions in January, and follow the same cultural routine. For maincrop sow as early in March as possible out of doors.

Marrows. The call for these comes about the end of May. Seeds of both bush and trailing varieties should be sown in the growing-house about mid-April and the plants potted on into 48's for sale. They should be grown sturdily and hardy, so that they do not suffer a check when planted out in the open.

Bedding Plants

The demand for spring and summer bedding plants is very heavy, and will increase by leaps and bounds as the post-war building schemes develop. It is a lucrative trade, and one worth fostering. A reputation for fair dealing is of value in this, so that customers return year after year, enabling one to clear the stock at retail prices and without the expense of too much advertising.

Geraniums. The geranium so popular in suburban gardens is actually a pelargonium; the true geranium is a herbaceous plant. However, it is as "geranium" that the pelargonium is best known, and the nurseryman is not likely to confuse his customers by offering them a plant under an unfamiliar name, even if that name happens to be the correct one. We will therefore here call the plant geranium.

Far and away the most popular variety is Paul Crampel —the vivid scarlet familiar to all. Plants suitable for selling in late May are obtained from cuttings struck in August and September. Sufficient stock must be kept back each year to provide these cuttings. Speaking generally, one may expect to secure four good cuttings from one plant, so if one plans to raise 1000 plants for sale, about 350 plants should be put out for stock purposes, which will produce round about 1400 cuttings, thus providing for next year's stock in addition to the plants for sale, and a margin for inevitable losses.

The cuttings are struck four in a 60 size pot, the pots being packed tightly in a half-shady frame. In November they are removed to the greenhouse, and in January they are potted singly into large 60's, using a fairly rich sterilized compost. As the plants grow they will need more room. In April they may be thinned out by transferring the

largest to cold frames, leaving the smaller plants to grow on to a good size in the growing-house.

ANTIRRHINUMS. These are also immensely popular. A fair selection of colours should be chosen—say yellow, red, pink, orange-scarlet, salmon-scarlet, and very deep red. The brighter colours are usually the most popular; white is very seldom asked for.

Seeds are sown in the propagating house in January and the seedlings pricked off $1\frac{3}{4}$ in. apart each way, or so that a standard nursery box holds about four dozen. This is suitable work for girls, whose nimble fingers acquire great dexterity. It is often paid for at piecework rates. The soil used for seed-boxes and nursery boxes should be sterilized, if only to kill the weed seeds.

A good organic fertilizer such as fish guano should be mixed with the compost; this will help the plants when they are becoming root-bound in the boxes. The seedlings should be flooded in immediately after transferring to the nursery boxes. In April they should be moved to the cold frames to harden off.

FIBROUS-ROOTED BEGONIAS. These are easily raised from seed and grown on to saleable size if the necessary heat can be maintained. The seeds are sown in December or early January in a temperature of 65–70° Fahr. The seedlings are somewhat slow to grow at first, but as soon as they are large enough to handle they should be pricked off into boxes, using a rich compost, and then potted into 60 size pots when sufficient growth has been made. All this time they should be kept in a temperature never much below 60° Fahr.

Gradual hardening off may commence in April, and by the end of May the plants will be sturdy, attractive stuff ready to come into flower. The pink and red shades are most saleable.

Dahlias. Bedding and the large dahlias are very popular, and, inasmuch as they are being used more and more in the public parks, are likely to increase in popularity with amateur gardeners. For bedding, Coltness Gem, Brentwood Yellow, Princess Marie Jose are three popular kinds of many. Of the cactus and decorative types the number of varieties is legion.

The plants are propagated by cuttings taken in February and March. The old tubers are packed on staging in a temperature of about 60° Fahr.; a little soil or peat is worked round them, and they are kept moist. The cuttings are taken off with or without a heel of the tuber attached and are struck in a propagating case, four to six in a 60 size pot. When the cuttings have struck they are potted off singly in 60 size pots and grown in a temperature of about 50° Fahr. until they are ready for hardening off in early May.

Sufficient plants must be kept back to provide stock for next year. The tubers are dug up in autumn after the tops have been cut by frost, and are stored in a frost-proof but not hot place.

Pansies. These always command a good sale in spring. Seeds of a first-class strain, such as Engelmanns, Bath's, Sutton's and other good firms, are sown in summer; the seedlings are pricked out 3 in. apart each way into cold frames, and the plants are protected from excessive cold and wet by the lights. In early April the lights are removed for good and the plants hardened off ready for sale.

Violas. These are seldom raised from seeds, but are propagated by cuttings struck in cold frames in October. In July the stock plants should be cut over to provide fresh young shoots, which form the best cuttings. The plants find a ready sale in spring, when usually each

cutting begins to flower. Mauve and yellow are the most popular colours.

Polyanthus. To provide good plants for autumn or spring sale seeds of a good mixture are sown in heat in January and the seedlings planted out on to rich, cool soil in March or April. Alternatively, plants may be split and planted on a shady border after flowering.

Wallflowers. These provide plants for autumn sale for bedding and for spring cut flowers. The seeds are sown in the open ground in May–June and the seedlings are planted out 6 in. apart in rows 1 ft. apart. The soil should not be over-rich, or soft growth ill fitted to withstand the rigours of winter will be produced.

Other plants for which a market exists are such annuals as nemesia, phlox *Drummondi*, scabious, calendula, aster, stocks, cosmos, nicotiana, tagetes, and dianthus; and the biennials Sweet William and Canterbury bells.

CHAPTER XIV

CHRYSANTHEMUMS

As the most important of the cut flowers, chrysanthemums deserve a chapter to themselves.

The season of the flower now extends from July to January—or even February in some districts. From July to mid-September the flowers are produced out-of-doors; from mid-September to late October in unheated greenhouses and with temporary protection; and from November until the end of the season in houses from which damp and frost may be excluded.

Where a continual demand has to be met the grower has to cover all the season. This involves growing several varieties, a good deal of time and labour has to be accorded the crop, and a fair area of ground is required. On the whole it is best for the beginner somewhat to limit his ambitions and grow say two varieties only in each section. Thus he will have a useful number of blooms for disposal at any one time—a factor of importance.

The cultural procedure is different for the different seasons, and in addition there is a special trade for chrysanthemums in pots. We will therefore treat of each separately.

July–September

This is the " easiest " season, and in consequence the blooms bring in the smallest return. But the income is useful, particularly if retail prices can be obtained.

Varieties. A few of the most popular varieties are

Almirante, September, a fine chestnut-bronze; Cranford, mid-August, golden-yellow; Elsenham White, September, pure white; Mrs. Douglas Foxwell, August, bright crimson; Sanctity, September, pure white; Mrs. Phil Page, July, chestnut-red, the most popular early variety. There are many others.

Propagation. Chrysanthemums are increased by cuttings of the growths which rise with greater or less freedom from the bases of old plants. Usually early varieties produce an abundance of cuttings. In autumn the plants from which the flowers will have been cut are dug up, the soil shaken from the roots, the stem cut to within 6 in. of the root and the roots are packed close together in a cold frame or unheated glasshouse. A little soil to which some lime has been added is worked amongst the roots. Very little water will be required during winter.

With the turn of the year growth commences, and in March the cuttings are taken. Each cutting should come preferably from the outside of the old stool; those near the stem are usually weak, and those on the stem itself are useless. The bottom pair of leaves is removed and the stem cut across just below the next joint with a sharp knife. The cuttings are dibbled into boxes filled with a compost consisting of 6 parts light loam to 1 part coarse silver sand. No fertilizers or manure should be included. The distance apart is 2 in. The base of the cutting is buried just sufficiently to enable the plant to stand upright. The cuttings are flooded in, and no more water is needed for several days, though they may be syringed over daily if they show signs of wilting. They should be kept in a temperature of about 50° Fahr. day and night.

The cuttings will root in seven to fourteen days, and should then be removed to a cold house or frame. Before the plants become root-bound they should be set out in

about 5 in. of steam-sterilized soil in a cold frame. Below the soil should be ashes. Ventilate very freely, and keep the plants somewhat on the dry side to prevent excessive and soft growth. About mid-April pinch out the tips of the plants.

Planting Out. The soil in which the chrysanthemums are to be flowered must be well drained, and double-digging or subsoiling is desirable. A dressing of manure should be given when this work is done in autumn. In spring a dressing of lime is worked in with the cultivator and just before planting out bone-meal, 4 oz., and muriate of potash, 1 oz. per sq. yard, are thoroughly incorporated with the top 9 in. of soil. The land is then firmed to conserve moisture. In late April or early May, according to district, the plants are put out 18 in. apart in rows 20 in. apart. Make the plants very firm.

Staking. The effect of removing the tip of the plant is to cause three or four side-shoots to develop. When these are 2 or 3 in. long they in turn should be stopped. The plant will now develop from eight to twelve shoots which will bear the flowers. These shoots must be supported, or they will be snapped off by wind. A bamboo cane 4 ft. long should be put to each plant and the shoots secured with a single loop of raffia.

Disbudding. Usually only one flower per stem is allowed to develop, and to secure this the plants are disbudded—that is, all the buds except one, the strongest, are removed as soon as sufficiently developed, and henceforward any buds developing on laterals are rubbed out as fast as they form. If all the buds are left to develop naturally the stems form sprays of flowers, but these are not so popular as disbudded flowers.

Mid-September–Late October

Both frost and wet are enemies of chrysanthemum flowers, and the varieties grown to flower in this period require protection as the flowers expand. This is given in one or other of two ways—either by moving the plants into Dutch houses or other unheated houses or by giving temporary protection where the plants grow. In the former case the plants are either grown in pots or are "lifted" from the open ground. The former is the method to be recommended, although it involves more work. However, excellent flowers may be produced in Southern districts by the temporary protection method. All three methods will be described in due course.

Varieties. Blanche du Poitou, October, white; Golden Ace, October, golden-bronze; Red Ace, October, crimson; The Ace, October, golden-bronze; Yellow Gown, September, yellow; Wendy, September, orange-amber.

Propagation. The outline for propagation is as for early varieties, except that the cuttings are taken somewhat earlier. If possible the complete batch should be secured during January. The rooted cuttings of plants to be finished out of doors or which are to be lifted are planted out as advised for the early varieties. Plants to be flowered in pots are treated differently.

Growing in Pots. When the cuttings are well rooted they are potted three in a large 60 size pot, in a compost of 7 parts medium loam (sterilized), 3 parts good peat, 2 parts coarse silver sand, adding to each bushel of compost 1½ oz. superphosphate, ¾ oz. sulphate of potash and ¾ oz. ground limestone. The plants are grown on under cool conditions until they require another move; they are then potted into 5-in. pots, in the same compost.

In April the plants are removed to the cold frames and given plenty of ventilation. The final potting is into 10-in. pots, and takes place when the 5-in. pots are full of roots. A somewhat richer compost is used, the peat being replaced by 2 parts well-decayed dung to 7 parts of loam and a little old soot mixed with the other ingredients. Pot very firmly, using a potting-stick to firm the soil. The plants are then staked and stood on a bed of ashes. Watering must be daily attended to; in the height of summer it may be necessary to water twice or three times a day, and the plants benefit from an overhead spraying in the evening.

The plants are stopped twice, but the number of growths allowed per pot is usually limited to twelve, and better flowers are obtained when only nine—three per plant—are allowed to develop. Disbudding is carried out as for early varieties. If the plants appear in need of a stimulant a good complete chrysanthemum fertilizer may be used. Whether or not this is necessary will depend on the quality of the compost. In late September the plants are transferred to the houses where they are to flower. No heat is needed or desirable.

Growing for Lifting. I do not recommend the practice of "lifting" chrysanthemums to the beginner, and the practice is becoming less common among experienced cultivators. However, for the sake of completeness, an outline of the procedure will be given. The plants are grown as for early varieties. About a fortnight before they are due to be taken inside the roots are cut with a sharp spade about 6 in. away from the stem and half-way round the plant; the other half is treated similarly about a week later. In this way new roots are formed close to the stem which both support the plant and help to hold the soil together when the plants are lifted. Lifting is a

laborious job, which must be done with great care. A low, rubber-tyred truck is useful for running the plants into the houses. The plants are put in about 1 ft. apart and soil worked amongst them. They are then given a good watering, and shaded if they show signs of wilting.

Plants to be Protected Out of Doors. In the South the method of giving the plants the slight protection they need to safeguard them from frost and rain where they grow is becoming more and more popular. Many growers who adopt this method grow the plants in beds consisting of three rows 16 in. apart, with pathways about 30 in. wide between each bed. When the time for protection comes stakes about 4 ft. long are driven into each corner and about 10 ft. apart down the sides of the beds. Down the centre of the beds stakes 1 ft. longer are driven. Lighter wood—about 2 in. by 1 in. is suitable—is then fastened to the tops of the stakes. This forms the framework for a span-roof. Canvas sheets about 6 ft. wide are laid over the framework at night or during heavy rain and secured by strings to the posts. If the stakes are treated with wood preservative they will last for many years.

November–January

The best blooms for this period are grown almost exclusively in pots, and flowered in glasshouses where a little heat can be given when the weather turns really cold and wet.

Varieties. These are very numerous in this section. A dozen or so of the best are: Bronze Light, November, chestnut-bronze; Fiona, November, brown and gold; H. W. Thorpe, November, white; May Parker, November, yellow; Autocrat, December, white; Balcombe Bronze, December, bronze and yellow; Baldock's Crimson, late December, deep crimson; May Wallace, late

December, pink; Thanksgiving Pink, late December, satiny-pink; The Favourite, December, white; Absolute, November, orange-chestnut single; Golden Seal, November, yellow single; Mason's Bronze, November, bronze single.

Propagation. The cuttings are taken as early as possible —from mid-December to mid-January in the season—and the best plants will be grown from the cuttings secured during the first half of this period.

General Cultivation. This is as for November varieties grown in pots. The plants are housed in late September, but are allowed free ventilation for some time after housing. The aim is to keep them back, rather than to hurry them on. Slight heat is necessary during November and December—just sufficient to keep the air buoyant and dry.

Chrysanthemums for Sale in Pots. These are suitable for sale only in markets near the nursery. The heavy rail charges do not permit of sending the plants any distance. The type of plant required is dwarf and stocky with about eight flowers and growing in a 6-in. pot. To produce a healthy-looking plant in such a small pot is a test of skill, but it is done by the real nurseryman.

Varieties. Among the most popular are: Blanche de Poitevene; Bronze Cranfordia; H. W. Thorpe; Kathleen Thompson; Pink Delight; Yellow Thorpe; Winter Cheer.

Propagation. The cuttings are taken as late as possible. May is the best month. They are struck in cold frames, but usually in pots, three per 60 size pot.

Growing. When the cuttings are well rooted the stems are pinched hard back nearly to ground level. The growths resulting from this stopping are in their turn stopped; a third stopping may be necessary if the plants

grow quickly. The aim is to keep the plants dwarf. The resulting growths per pot are reduced to twelve, or four per plant.

When the cutting-pots are well filled with roots the plants are potted on without separating them into 6-in. pots. They are stood on ashes out of doors. Watering and feeding are as for the larger plants, except that it will be necessary to do both oftener to maintain healthy growth. The plants are housed with the others. They are invariably disbudded. If cultivation has been good, an attractive symmetrical plant furnished with twelve flowers is produced, and such command a ready sale. A neat mode of staking is to insert a bamboo cane down the centre of the pot and secure each stem individually to this by loops of thin raffia.

Cutting and Packing

Flowers to be sent a distance are cut early in the day, and are stood for several hours in pails filled with water, so that the stems become well charged before they are packed. They are cut with stems as long as possible and just when they are beginning to become fully open—when the outer petals are expanded but with the inner petals still curled over the centre.

Light non-returnable boxes are used for packing the blooms. The boxes are lined with paper. A row of blooms is then put in and secured with a wood stick wedged in about 1 in. below the flowers. A second row is then put in, the flowers resting between the stems of the first row; this row is in turn secured, and so on until the box is filled. A box should contain only one colour and size of bloom, and when filled with flowers should have a level, even appearance. The paper is folded over the flowers and the box lid fastened down.

CHAPTER XV

GLASSHOUSE SWEET PEAS

Sweet peas are fairly extensively grown in glasshouses in the south-east corner of England, where winter and early spring sunshine is abundant and where the necessary temperature can be maintained without expensive firing over long periods. In Northern, Midland and Western districts the crop is grown very little if at all in glasshouses. In most cases the light intensity in these districts is too low for the successful cultivation of the crop out of its " normal " season. The plant is grown to flower under glass from March until the outdoor supplies come in in June. Usually indoor supplies cease during May, and the houses are immediately planted with tomatoes. Inasmuch as the crop is confined to certain districts (although artificial illumination may in the future alter this to some extent), the market does not easily become glutted, and prices are usually satisfactory. Before attempting sweet peas, however, the beginner must be sure that his nursery is situated in a district suited to the crop.

Varieties. For earliest supplies American—mostly Californian—strains are used. These flower much earlier than the English strains. These early strains are sufficiently distinct to be designated as " types ". Among the most popular varieties of the early type are Early Chime; Burpees Giant Rose, Rose Queen, and Ball's Rose, all attractive shades of pink, and Early Memory and Harmony, which are good lavenders. The popular main crops

John Topham

Bedding plants always find a ready sale at remunerative prices, and geraniums are a good line to have on offer. The cuttings are taken and struck in autumn, in preparation for sale in May. A good plant should provide four cuttings, perhaps five.

Smallholder

Typical Christmas gift, the solanum with its bright orange-red berries is but one of the pot plants that sell well and are comparatively easy to propagate. Others include maidenhair fern, cyclamen, cinerarias and primulas.

include Ambition and Powerscourt, both mauves, and Pinkie, Debutante, Marion and Atlantic, which are shades of pink. The other colours in sweet peas are not much grown for forcing; the pinks and mauves are far and away the most popular.

Propagation. The seeds are sown in September in size 60 pots, four seeds in each pot. The compost used is chiefly light loam, with 2 oz. superphosphate and 2 oz. lime per bushel of soil added. Certain varieties produce seeds which are small and very hard and which are slow to germinate if the coat is not " clipped " before sowing. This is done with a small file, taking care to file only through the coat or testa, and not to damage the embryo plant in the seed. The seeds are germinated in a temperature of about 60° Fahr. As soon as the plants are through the soil the pots are placed on shelves near the glass, which must be clean, for maximum light is a necessity right from the start. Only just sufficient water is given to satisfy the plants' needs—overwatering must be avoided.

Growing. The plants will be put out in their flowering quarters in December (early varieties) and January (main-crop varieties). The house should be prepared in good time. The glass should be very thoroughly washed and any scum which has collected in the overlap of the panes cleared out. The soil should be double-dug, and a dressing of manure worked into the bottom spit, and superphosphate, bone-meal and lime, 3 oz. of each per sq. yard, worked into the top spit. The soil should also be sterilized as double digging proceeds, for there will be no time for this work between clearing the sweet peas and planting the tomatoes. Unless heavy dressings of potash were given to the previous crop, potash in the form of sulphate of potash should be given with the other fertilizers,

but no nitrogenous fertilizer should be applied at this stage.

The plants are put out 6 in. apart in rows 18 in. apart. A minimum head room of 6 ft. is required. Some form of support must be provided. The most popular takes the form of two wires, one at ground level and the other 10 ft. or so high (where this height is possible). Between these two wires thin strong string is stretched; the vine is secured to the string by raffia or the cheap wire rings sold for the purpose.

The temperature after planting out should not exceed 50° Fahr. and should be kept as steady as possible at this figure. Later in the season when the outside temperature is going up the inside temperature may rise to 60° Fahr. and be kept at this. Water must be given when required, but the soil must not be soggy; free drainage is essential to the crop. Ventilation should be given whenever outside conditions permit it, taking care to avoid cold draughts which cause the buds to fall.

Varieties of the early strains do not produce laterals to any appreciable extent. Laterals are, however, freely produced by the main-crop varieties, and these must be kept nipped out. The tendrils which are formed by both types should be cut off whilst small. When the vines have reached the top of the supports they (the vines) must be " dropped " in the same way as outdoor sweet peas grown on the single-cordon system are dropped.

When the plants are coming into flower a balanced sweet-pea fertilizer may be given every three to four weeks and watered in.

Picking and Marketing. The flowers are cut early in the morning and when all the blooms on the stem are nearly fully out. They are allowed to stand in water through the day in a cool place. They are then bunched twelve

flowers in a bunch arranged in four tiers of three blooms in a tier, with the flowers all pointing one way; the stems are secured with raffia. The bunches are packed eighteen to twenty-four in paper-lined boxes; paper-padded strips of wood are used to secure the bunches.

CHAPTER XVI

CARNATIONS

THE carnation is an important cut flower, but its cultivation is largely in the hands of specialized growers. It is not a crop which can be fitted in with other crops. The houses need to be specially constructed for it; they are expensive to build and maintain, and unless one proposes to specialize in carnations the crop is best left alone. This chapter will therefore be brief, and its principal purpose will be to deter the reader from entering lightheartedly into this branch of commercial horticulture.

Type of House Needed. The houses in which carnations are grown are the largest erected for any normal horticultural crop. They measure up to 40 ft. wide, about 6 ft. to eaves and 15–17 ft. to the ridge. The glass in the sides is carried nearly to ground level. The design is ruled by the need of the crop for good light and air conditions. Most of the nurseries specializing in carnations are in districts well away from industrial centres and where there is abundant sunshine. The heating pipes are overhead, and are often slung from the purlin posts 6–8 ft. above ground-level. In addition to the growing-houses described above a smaller propagating house adjoins. This may be 9–10 ft. wide, 4 ft. 6 in. to eaves and 8 ft. to ridge. The propagating beds are on either side of the central path. The heating-pipes run under the beds; sometimes one pipe is run just under the ridge.

Varieties. Among many popular commercial varieties are the following: White Pearl; White Wivelsfield;

Maine Sunshine (yellow); Saffron (yellow); Tangerine (apricot-orange); Leila (rose-lilac); Mabel Allwood (mauve); Robert Allwood (scarlet); spectrum (scarlet); Allwood's Crimson (red); Topsy (red); Mrs. A. J. Cobb (red); Giant Laddie (pink); Laddie (pink); Lassie (rose); Salmon Spectrum (salmon); Betty Lou (pink).

Propagation. Carnations are increased by cuttings taken from selected healthy young plants which are kept for propagation purposes only and are not allowed to flower. The most popular time for the work is November to February. A certain amount of propagation is, however, done at other times of the year. Beds of pure sharp silver sand are made up in the propagating house, and the cuttings—side shoots 3–4 in. long—are struck in these. One good watering is given after inserting the cuttings, and the temperature is maintained at 55° Fahr. and a close atmosphere produced. The cuttings take three to four weeks to form roots. The bed is watered as often as necessary. When roots have formed ventilation is increased and the temperature reduced to 45–50° Fahr. The plants are then potted into size 60 pots in a good light loam with a little lime mortar-rubble. They are then transferred to the larger house to obtain the benefits of light and air.

Growing. Some growers flower the plants in 5–6 in. pots, others plant out in beds. The former enables any diseased plant to be immediately withdrawn and localizes the infection, particularly of root troubles; the latter reduces the amount of work in watering, and so on. The beds are constructed of concrete, with drainage provided by drain-pipes. They are built to allow a depth of 6 in. of soil. The compost used for both beds and pots is formed of the top spit from a rich pasture which has been allowed to decay in a stack for six to twelve months.

It is sterilized to destroy wireworms and other harmful organisms. Sulphate of potash and lime, at the rate of 2 oz. per bushel, are mixed with the soil after sterilizing.

The plants to be grown in beds are set out 1 ft. apart each way. Support for the flowers is provided by wires stretched lengthwise and across the beds 6 in. apart and about 9 in. above the soil, so as to form squares through which the flower-stems grow and are supported.

Water is given only when required, the plants then being watered liberally and left until water is again needed. The air is kept dry and buoyant, and ventilation —provided by vents in roof, sides and ends of the houses— is always liberal. A night temperature round 50° Fahr. is general.

The plants are fed occasionally, either with a good carnation fertilizer or with a home-made complete fertilizer, of which the following is an example:

Hoof and horn 1 part,
Guano 1 part,
Sulphate of ammonia 1 part,
Superphosphate 1 part,
Bone-meal 1 part,
Sulphate of potash 1½ parts.

The mixture is applied at the rate of 4–6 oz. per sq. yard, according to the needs of the plants.

A succession of flowers over a period is induced by " stopping " certain of the growths when 6 in. or so long.

Cutting and Packing. The flowers are cut just before they are fully expanded, and are placed in buckets of water for twenty-four hours, so that the stems become turgid with water before the flowers are packed for market. The boxes used measure 36 in. by 12 in. and

4–5 in. deep. They are lined with paper. The flowers are packed carefully in single rows, each row being held in place by a stick padded with soft paper which provides the support for the next row. Each box holds two to three dozen blooms, according to size.

CHAPTER XVII

BULB FORCING

NEXT to chrysanthemums, narcissi and tulips are the most important cut flowers in the general nursery. A vast trade is done in forced blooms from December until the outdoor flowers come in.

Both narcissi and tulips may be forced in tomato-houses, and the large house depicted on page 34 is quite suitable. Flowers for very early work—for Christmas—which need a fairly high temperature, may be finished in the forcing-houses.

The bulbs used for forcing must be of tip-top quality. Weight and firmness are as important as size. Suitable bulbs are produced on the rich bulb-lands of Lincolnshire and in Holland. Unless land of the necessary quality is attached to the nursery new bulbs have to be purchased every year. In any case the production of bulbs for forcing is a specialized job, requiring some experience and certain equipment.

NARCISSI

The narcissus is a typical British flower, which is never likely to lose its popularity with the buying public. In addition to the great quantities sold for room decoration, the florists absorb a goodly proportion of the production for wreath-work.

Varieties. Paper White and Soleil d'Or are the earliest, and are forced into flower by mid-December or earlier from bulbs imported from southern France. They are of

the Tazetta or Polyanthus types. The trumpet varieties Golden Spur, King Alfred, Emperor and Victoria follow, with the Incomparibilis Sir Watkin and Croesus and the Barii Bath's Flame and Lady Moore. The Poeticus group, Ornatus Maximus and Homer, finish the season.

Boxing Narcissi. On receipt from the grower the bulbs are sorted into sizes. If "forcing quality" has been specified, all the bulbs should be hard and of a good size for the variety. The bulbs must be ordered in good time and should be delivered during August. The boxes used measure 12 in. by 10 in. by 5 in.; such will hold about thirty bulbs. Ordinary soil is used for the boxes; it must not contain any manure. After boxing, the bulbs are stood on a level ash bottom in a shady space; they are then watered and covered with ashes, soil, or peat to a depth of 2 in. This induces the formation of a good root system—a necessary concomitant to successful forcing.

Forcing. The earliest varieties are ready to be moved into the houses about mid-November. The temperature at first should not be higher than 45° Fahr.—a temperature that is also suitable for November chrysanthemums. It is raised to 55° Fahr. after a week (this may necessitate moving the boxes to the forcing-house) and is gradually increased to 65° Fahr., which should not be exceeded.

The later varieties are moved in in their order, but not before a good root-system has developed and an inch or so of top growth has been made. The maximum amount of light is necessary. Water must be given unstintingly when the plants are in full growth.

Cutting and Packing. The flowers are cut just before they are fully expanded, and are graded and bunched six to twelve in a bunch, according to the season, with the flowers all pointing in one direction. The stems are secured top and bottom with thin rubber bands. The

bunches are packed tightly but carefully in boxes lined with paper. The boxes may be either of the returnable or non-returnable kind.

The bulbs are of no further use for forcing, but may be planted out in the open, where they will recover and flower in a year or two, or they may be sold for naturalizing in private gardens.

Tulips

The general routine for forcing tulips is somewhat similar to that given above for narcissi. Perhaps a little more skill is needed, but not so much as to make the crop in any way doubtful, provided the elementary rules are followed.

Varieties. These are divided into early singles, early doubles, and Darwins. Of the early singles, Mon Tresor, yellow; Prosperity, pink; General de Wet, orange-scarlet; Rose Precose, pink and white; and Prince of Austria, orange-red, are popular. Of the early doubles, Peach Blossom, pink; Vuurbaak, scarlet; and Murillo, blush-white, are good, and are in demand for wreath-making. The Darwins are forced in larger numbers than either of the above. Some of the most popular varieties are: William Copland, lilac; Bartigan, reddish-crimson; City of Haarlem, crimson; Princess Elizabeth, rose-pink; Baron de la Tonnaye, rose; Allard Pierson, deep red.

Buying the Bulbs. Bulbs for forcing not only need to be of good weight and substance, but have to be " prepared " for forcing by being subjected to certain temperature conditions. This the grower does, and bulbs sold as " suitable for early forcing " or for " mid-season " or " late forcing " have been subjected to this special treatment. The beginner cannot do better than go to an old-established and reputable firm for his supplies.

Boxing Tulips. The earliest varieties are boxed in late August or early September, the Darwins three weeks or so later. The same size of box is used as for narcissi. The early varieties are planted close together—about 1 in. apart—to induce length of stem: always difficult to obtain with these. The Darwins are planted 2 in. apart. Fresh loam which has not grown tulips before is used for the boxes and a little bone-meal is mixed with it. The bulbs are planted with their tips about $\frac{1}{2}$ in. below the top of the soil, which is made very firm in the boxes. The boxes are watered and plunged as advised for narcissi.

The early varieties are ready to bring into heat about the beginning of December. About 50° Fahr. is a safe temperature at first for most varieties; it may be gradually increased to 70° Fahr. for the early kinds. To produce a greater length of stem early varieties are heavily shaded until the flower begins to open, when full light is given and the temperature is lowered 5° Fahr.

The Darwins follow the early varieties. The temperature for these must not be allowed to rise so high as for the early kinds. About 60° Fahr. produces the best type of flower. When this temperature is reached it must be maintained steadily. Violent fluctuations of temperature are fatal to tulips. The Darwins also need full light, as they naturally produce long stems. A day or two before the flowers are ready for cutting the temperature is again lowered by 5° Fahr., and free ventilation is given. Throughout the growing period watering must be carefully attended to, and the house kept slightly on the damp side; tulips like a moist atmosphere.

Cutting and Packing. The flowers are cut with the longest stem possible—usually level with the top of the bulb. In the early varieties the bulb is sometimes split in half to obtain the length of stem in the bulb. This

may be done, as tulip bulbs are useless, and are discarded after forcing.

The time of cutting is when the petals are beginning to expand and to assume their colour. The flowers are bunched a dozen in a bunch and tied with two ties of raffia, one to secure the leaves and the other at the base of the stems. The bunches are packed in boxes, which are first lined with paper, and are placed with heads at both ends of the box, and secured with a stick across the centre. Only one variety and grade of bloom is put in a box.

CHAPTER XVIII

OTHER FLOWERS FOR FORCING

THE flowers dealt with in the foregoing chapters do not exhaust the number that is grown for forcing. Indeed, this is quite large, but not all can be considered suitable for the beginner. For some the demand is limited and erratic; others must be deemed too difficult and "chancy". The following are, however, popular and come within the scope of the general nurseryman: freesia, gerbera, gladiolus, hyacinth, iris, lily-of-the-valley, stock and wallflower.

FREESIA

There is a useful if somewhat limited demand for freesias, and one should feel one's way a little before embarking on too extensive cultivation of the crop. The white variety, freesia refracta alba, is grown for use in wreaths and bouquets; the coloured varieties sold as coloured hybrids are grown for cut flowers.

The bulbs are obtained in August, and potted or boxed in light open loam, free from manure, mixed with peat and silver sand. No fertilizers are necessary if the loam is from a fertile pasture. The receptacles should be plunged under leaf-mould in a shady corner. After six weeks they should be examined very frequently, and as soon as the growths are an inch long they should be placed in a frame in full sunshine.

About the end of October the plants should be brought into a cool glasshouse, the temperature of which should

be gradually increased to 55° Fahr. This temperature must not be exceeded, or the plants will fail to flower. Plenty of light and moisture is needed, but free drainage must be assured, for stagnant water about the roots will quickly kill them.

The flowers are cut when the lower ones of the spike are open, stood in water for twelve hours, and then bunched in dozens for market. The foliage must be left on the plant, and the plant dried off slowly. When the foliage has completely died down the bulbs are shaken out of the soil and stored for forcing the next season.

Gerbera

This is a South African composite which produces flowers of rich shades of orange, pink, yellow and other like colours. Until the war put a brake on flower production it was becoming very popular. There will be need to watch the market to see if it regains its popularity. The plant is a half-hardy perennial, but is easily flowered as an annual, and, as difficulty is experienced in keeping the roots through the winter, it is as an annual that it is usually grown. The seeds are sown early in spring and the plants put out a foot each way on very well-drained soils and in the sunniest place possible.

With the end of hot summer weather the plants should be covered with Dutch lights, or a temporary Dutch house erected over them. They will then continue in flower through the autumn and well into winter. The plants are very sensitive to moisture, and both the house or frames and the soil should be kept on the dry side during winter. If they survive the winter they should be allowed to grow on the following summer, when a heavier crop of flowers will be produced.

The flowers of the type plant Gerbera Jamesoni are

orange-scarlet in colour, but the mixed hybrids are usually grown. These are marketed in bunches of well-mixed colours.

Gladiolus

This is a very popular subject and one whose popularity is not likely to wane. There are three main groups of the flower: Colvillei and nanus (which are the first to flower and thus the easiest to force), the large flowered, which is the most widely grown, but not so easily forced as the first group; and primulinus hybrids, which flower at the same time as the large-flowered but have smaller flowers in lighter and more graceful spikes. As the cultivation of the different groups differs slightly, we will deal with them separately.

Colvillei and nanus. The most popular variety of G. Colvillei is albus, a pure white, sometimes also listed as The Bride. This is grown for wreath and bouquet-work, and also for sale as a cut flower. There are several varieties of G. nanus; the pink and white varieties are likely to command the readiest sale. A new strain of the early flowering group, called The Herald, has been developed for market-work and may become very valuable.

The corms for forcing are boxed in deep boxes in August in mellow loam and peat and a dash of silver sand. The compost should not contain any manure. The boxes are placed in cold frames and watered when necessary. In November or December, when a good root-system has been formed, the boxes are transferred to a house in which a temperature of about 50° Fahr. is maintained. This may be increased to 55° Fahr. as the plants grow, but this temperature should not be exceeded.

Large-flowered Gladioli. These are grown and sold in vast

numbers, and at times the market becomes glutted with blooms. The writer has seen blooms of superb quality sold at prices which barely repaid the cost of the corms. The earlier supplies, however, usually clear quicker and at profitable prices. These are obtained by planting the corms in Dutch houses or under Dutch lights so that growth is forwarded by about six to eight weeks. There are many varieties. The most popular for forcing are Flaming Sword, scarlet; Prince of Wales, peach; Mount Everest, white; and Lilac Wonder, mauve.

The corms are planted in beds either in cool glasshouses or frames; from the former flowers are cut in June if a temperature of about 50° Fahr. is maintained, or from late June to July if no heat is used. Some success has been achieved by heating the soil of cold frames, and the flowering period has been forwarded three to four weeks by this means. The soil should be open and fertile but free of any recent manure. If it lacks phosphates or potash these should be applied in the form of steamed bone-flour and sulphate of potash. Plant the corms 4 in. deep and 6 in. apart.

Primulinus Hybrids. The cultivation of these resembles that of the large-flowered types and the period of flowering is about the same. The flowers are smaller and the spikes are less densely crowded. By many they are considered more graceful. The corms are smaller and are planted less deeply—about 3 in. and 4–5 in. apart. The best variety for forcing is Scarletta, a bright scarlet. Good varieties for forwarding in frames are Arton, salmon pink; Maiden's Blush, blush pink; Salmonea, pink and apricot.

Cutting and Marketing. The flowers are cut when the bottom two of the spikes are open. The stems are stood in water for some hours, and are then bunched into

Sport and General

The ever-popular tulip gives its best return when forced under glass for the early market, although in some areas outdoor bulbs pay well in sheltered positions. The Darwin type are favourites for both methods.

C. Harris

Wreath-making is an art well worth learning. If a shop is run in conjunction with the nursery and a few specimens are always on show, orders soon begin to come in.

bunches of one dozen and the bunches packed in wooden boxes, paper-padded sticks being used to fasten the stems.

Hyacinths

White Roman Hyacinths are forced for cutting mainly for wreath-making. The bulbs specially grown and prepared for forcing are somewhat expensive, and prudence will suggest that the reader should have some idea of the return he may expect before embarking on the crop on an extensive scale.

The bulbs of Roman hyacinths are imported from France. For earliest work they are obtained and boxed in August. Successional batches are put in in September and early October. These later plantings may prove disappointing in regard to price realized. New loam of a light fertile character is used for the boxes, sufficient sand being added to ensure free drainage. The "nose" of the bulb should be just above the soil. The boxes are then placed in a shady corner and covered with a layer of clean sand and then 3–4 in. of old ashes.

When a good root-system has been formed—which is six to eight weeks after boxing—the boxes are transferred to a cool house with a temperature of about 45° Fahr., and the plants are kept shaded. Gradually the shade is reduced and the temperature increased, until by the time the flower-spikes are appearing the plants are in full light and the temperature is about 65° Fahr. Hyacinths require a moist atmosphere and plenty of moisture at the roots.

Cutting and Marketing. The spikes are cut when the bottom flowers are fully open; they are stood in water for some hours in a cool, dark place and then bunched and packed in paper-lined boxes.

Iris

The Irises grown for cut flowers are of the bulbous kinds. The most useful and popular are iris *Tingitana* and Dutch irises.

Iris *Tingitana* is used for early work, and may be brought into flower in December. The bulbs are obtained as soon as possible after mid-August and are boxed as soon as received. The boxes should be not less than 4 in. deep. Very rich soil is not needed. A fertile light loam free from manure is suitable: with each bushel 1½ oz. of sulphate of potash and the same amount of lime should be mixed. Plant the bulbs 1½ in. deep and 4 in. apart. Water the boxes and then plunge them under 4 in. of old ashes in a shady corner. A good root-system will have been formed in about eight weeks from boxing. The boxes should then be transferred to a house in which the temperature is about 45° Fahr.

Irises must be forced very slowly and the temperature should be raised gradually to 55° Fahr., which should be reached when the flower buds are forming. Actual opening of the flower buds may be hastened by a further 5° rise in temperature and this must be regarded as the maximum. Abundant ventilation is necessary under the higher temperatures. Water freely whenever necessary.

Dutch Irises

There are several varieties of this plant. Amongst the best for forcing are: Imperator, Wedgwood, Yellow Queen and White Excelsior (the latter is good for wreath work). The bulbs are boxed during September and October, and follow iris *Tingitana* through all the processes of forcing. The earliest boxes may be had in flower at Christmas.

Cutting and Marketing. The flowers are cut when just

open and are stood in jars of water in a cool place for some hours before being bunched in dozens and packed in paper-lined boxes for market.

Lily-of-the-Valley

This plant is included because before the war it was useful and profitable. The crowns, however, were imported exclusively from Germany, and whether these imports will start again I do not know. English growers may be able to produce suitable crowns cheaply enough to supply the nurseryman. Lily-of-the-Valley crowns may be retarded by storing in a temperature about 4° below freezing point, and can be flowered almost at any time. The crowns, packed in bundles of twenty-five, are so stored, and are withdrawn from the refrigerator in batches from October onwards. The roots are packed lightly in 6-in. pots, in a sandy soil. The house is maintained at 70–80° Fahr. and is heavily shaded. Under these conditions growth starts at once, and the flowers are produced in about eighteen days.

Marketing. When the flowers are just opening the plants are knocked out of the pots and the roots washed clean of soil; the whole plants with roots entire are then bunched in dozens and packed in paper-lined boxes.

Stocks

These are much used during the winter months for wreath-work and for sale as cut flowers. For the former purpose All the Year Round and Snowdrift are good (both white) and Heatham Beauty and Beauty of Nice are attractive shades for sale as cut flowers. All these are of the Ten-Week type.

A good strain of seeds should be purchased, so that the proportion of double flowers is as high as possible. The

seeds are sown in July or early August, the plants are planted out 3 in. apart in good soil in a frame, and are transferred to the glasshouses when the tomatoes have been cleared, planting them 1 ft. apart each way. A temperature of 50–55° Fahr. ensures steady growth, and should not be much exceeded. Ventilation should be given whenever possible after the plants have become established.

Cutting and Marketing. The stems are cut entire when the flowers of the bottom branches are open. They are then bunched in dozens and packed in wooden boxes lined with paper.

Wallflowers

These are a popular cut flower, although the prices secured do not permit of an expensive programme. Suitable varieties are Vulcan, Feltham Early, Cloth of Gold and Early Orange. The seeds are sown in late May and the plants pricked out 9 in. apart each way. They must not be disturbed again, but should be covered in February with Dutch lights. Simply surrounding the beds with hessian sacking forwards the flowers by several days, and it is the flowers on sale two to three weeks before the unprotected flowers come in which fetch a price which repays the trouble taken.

Cutting and Marketing. Only the best blooms should be marketed. The stems are cut as long as possible and when the bottom flowers are just opening. They are bunched in dozens and packed in boxes.

CHAPTER XIX

POT PLANTS

THERE is a constant and ready sale for plants—both foliage and flowering—in pots. The most popular kinds call for no great skill or special conditions for their production. It is necessary, however, to know how to produce a good plant in a small pot, for the buyer is put off by a large pot which is weighty and cumbersome to carry. This luxuriant growth is obtained by the use of sterilized soil of good quality and by careful feeding.

The most popular kinds of flowering plants for cultivation in pots are: cineraria, cyclamen, primula *sinensis*, p. *stellata*, *malacoides*, hydrangea *Hortensis* and solanum *capsicastrum*, the last-named being grown for the beauty of its berries. Of foliage plants the ferns adiantum (Maidenhair fern), pteris *cretica major* and asplenium *bulbiferum* claim first attention. Asparagus *plumosus* is grown both for sale as a pot plant and to supply foliage for wreaths and bouquets; other foliage plants for which the demand is fairly constant are coleus and crotons.

CINERARIA

These may be had in flower at almost any time of the year, but are most profitable when grown to flower in the depth of winter. The large-flowered type are most widely grown. Seed of a strain of mixed colours should be purchased and the seeds sown early in May to have plants in flower at Christmas and January. Sow the seeds shallowly in boxes of light sterilized soil with peat

and sand added. The seeds germinate quickly in a temperature of 60–65° Fahr.

When the seedlings are large enough, pot off into thumb pots, using a somewhat coarse and fibrous loam, with peat and silver sand added. Return the plants to a warm house and maintain a warm, moist atmosphere until they have recovered; they should then be transferred to cooler conditions, and may eventually be grown on in frames.

The plants will soon require a move to large 60 size pots and again to 48 size; these moves should be given before the plants become starved and pot-bound.

During August and September—unless these months are unkindly—the plants may be stood out of doors in a half-shady but airy corner. At the end of August the last move into 32 size pots will be given, and at the end of September they should be moved into the houses. The heat may be gradually increased and weekly feeding commenced, a good complete fertilizer such as Clays being used. This should cease when the colours of the flowers show.

Cyclamen

This beautiful plant can either be produced from seed or from rested tubers. The former is the cheaper method, and good-sized flowering plants can be grown in about fourteen months. Seeds of a good-quality mixture should be sown in August in pans of light soil. They are slow and erratic in germination, and to prevent the need for frequent watering the surface should be covered with moss. A temperature of 60° Fahr. is suitable for raising the seedlings.

As the seedlings appear and grow large enough to handle they should be potted into thumb-pots, in a

compost the principal ingredient of which is good sound loam. A steady heat of 60° Fahr. is good for growing on the plants; it need not be more, but it should not be less. Pot shallowly at all times; the tuber should " sit " on the soil surface; it must on no account be buried.

As the plants grow they should be potted on into 60 size pots and then into 48 size. For the later potting some mellow old manure may be mixed with the soil. During winter the plants need all the light that can be given them; in summer slight shading is necessary, and a humid atmosphere should be maintained by frequent damping of paths and staging. The plant is intolerant of a dry soil, and water must be given as often as necessary.

The plants will flower in 48's, and as the soil becomes well occupied with roots feeding with a good complete fertilizer alternated with soot water and manure may commence.

Primula sinensis and P. stellata

The culture of these two plants is identical, for the latter is a development from the former. To have plants in flower in mid-winter, when they are most remunerative, seeds are sown in May. A good mixture will produce plants of many attractive shades. The seed is small and slow to germinate. The seed-pans should be carefully prepared, using light sifted loam and peat and plenty of sharp silver sand. Cover the seed very thinly and place the pans in a shady corner of a house in which the temperature does not rise above 70° Fahr. or fall below 55° Fahr.

As the seedlings become large enough to handle prick them off round the edges of 60 size pots and keep them growing in a moist, congenial heat. The next move will be into small 60's. In July the plants can be stood out of

doors in frames, keeping the lights handy so that they may be placed in position at once if inclement weather threatens. They will produce sturdy plants by this treatment.

In early autumn they should be returned to the glass-houses and the temperature raised gradually to 65° Fahr., at which the plants will flower. The last move into 48's need be given only to the strongest; plants in large 60's flower and sell well, and a large quantity can be grown in a comparatively restricted space.

Feeding should commence as soon as the pots are well filled with roots. A complete fertilizer may alternate with manure and soot-water. The compost used for the second and final pottings may be as for cinerarias.

Primula Malacoides

This plant is very nearly hardy, and requires growing under cool conditions from the sowing of the seeds to the time of flowering. For winter flowering—and the nurseryman is not interested in any other period—seeds are sown in March. Named varieties should be selected. The writer can recommend those developed by Messrs. Suttons of Reading. A temperature of 60° Fahr. is ample to germinate the seeds.

The seedlings are potted off into thumb-pots and later transferred to small 60's and then into large 60's. In the early stages the plants should be kept growing steadily in a temperature of 50–55° Fahr. In May they can be transferred to cold frames, in which they will spend all the summer, at first with the protection of the lights and afterwards freely exposed. The best plants may be potted on into 48's, and in this size fine specimens will be procured. In October, or before if the weather turns cold, the plants are returned to a cool house. To obtain

plants for flowering at Christmas the temperature may be raised to 65° Fahr., which will readily "force" good sturdy plants.

Hydrangea Hortensis

This is a remunerative plant to grow, but it requires a fair standard of cultivation to produce first-class specimens. The plants one sees in the shops in April and May are two years old from cuttings. They have four to seven good-sized flower-heads, and the colours are attractive pinks and blues. Among the best varieties are: Deutschland, Gertrude Glaka, La Marine and Niedersachsen. All these are good pinks which can, if desired, be turned into blues by the treatment to be described.

Cuttings are struck in a warm house in August, one in a 60 size pot, in a compost consisting chiefly of good loam made firm. The following spring the flower-head which forms in the tip is removed, and as soon as the side-shoots begin to develop the plants are potted on into 48's, in a rich compost containing some old cow manure. During the summer the plants may be stood out of doors on a cool ash-bed. Watering must be attended to regularly.

In October transfer to a cool house and reduce the amount of water. No heat is necessary until January, when gentle forcing may commence by placing the plants in a house from which frost is excluded. When growth recommences re-pot in 32's, shaking off a good deal of the old soil and using a compost consisting of 2 parts loam to 1 part of old manure and sand. Thin out the growths to five to seven strong stems. Gradually increase the heat to about 60° Fahr., water liberally, and as the pots fill with roots commence feeding with a good fertilizer or liquid manure.

Blueing of the flowers of certain varieties is effected by

various methods. One of the best is to dissolve 1 tablespoonful of saltpetre and ½ a tablespoonful of oxide of iron in 3 gallons of water, allow to stand for twenty-four hours; water the plants with the solution twice a week.

Solanum capsicastrum

This berried shrub is perhaps declining somewhat in popularity, but it is still sold in fair quantities. Plants may be raised from seeds sown in January, and with good cultivation such will produce saleable plants the first year. The larger plants are, however, two years old.

Sow the seeds in a light compost and in a temperature of about 60° Fahr. Pot off the seedlings into small 60 size pots, and as they develop pinch back the shoots to induce a bushy plant. This pinching must cease by May, when the plants should be ready to pot into the 48 size. Stand out of doors during summer on a cool ash-bed. Syringe frequently to ensure the berries setting, and water liberally.

Return the plants to the house in autumn and keep in a temperature of about 55° Fahr. If an insufficient crop of berries is set the first year to make the plants saleable grow on another year. In February cut back the growths to 2 in. of their bases, re-pot and grow on as before. A close, moist atmosphere is best for inducing a good set of berries, and the plants should not be set out of doors until the flowers have fallen.

Maidenhair Fern

The variety of adiantum usually grown commercially is A. *decorum*. It is of value both as a pot plant and for supplying foliage for bouquets, button-holes and so on. The florist needs a continual supply of fresh young fronds. A warm, humid atmosphere is necessary. The tempera-

ture must not fall much below 65° Fahr., and an average of 70° is usual. Fronds of the finest quality are obtained from plants grown in 9-in. pots suspended like hanging baskets from the roof, but good material for cutting, as well as plants in smaller pots for sale, are grown on staging.

The stock is maintained and increased by splitting the roots in February, planting the outside pieces in pots of a size suitable for the purpose, 9-in. for cutting (three pieces in each pot) or 48 size for sale as pot plants (one piece in each pot). The compost consists of turfy loam and sand with sometimes a little peat added. The necessary humidity is maintained by damping the staging and floor. The fronds must be kept dry; this must be borne in mind when watering the plants. The house must be heavily shaded in summer.

Pteris major, Asplenium bulbiferum and Asparagus plumosus

These may be grown together, for their cultural requirements are very similar. A temperature of about 60° Fahr. is sufficient; it may rise to 70° by sun-heat, but shading is necessary in the height of summer. Pteris *major* and asparagus *plumosus* are increased by division of the root stocks; asplenium *bulbiferum* by rooting the plantlets formed on the leaves in boxes containing loam, peat and sand and placed in a warm propagating frame. They are potted into small pots when growth has well commenced and on into larger pots as development decrees. The compost for all three consists mainly of good loam with the addition of sand and peat.

Ferns are marketed in "trays" holding twelve plants in 60 size pots or six in 48 size pots.

Crotons (Codiaeum) and Coleus

These two plants have very similar cultural needs and may be grown together in the same house. Their principal need is a high temperature (about 70° Fahr.) and plenty of light, except in the very hottest part of summer. Stock plants of crotons must be purchased, and the stock should be selected carefully for vividness of leaf-colouring, which is the plant's attraction. The stock is maintained and increased by cuttings taken in February and struck in a propagating frame. The plants are grown on in a moist heat. Frequent damping down is essential, and the plants must never suffer from lack of water.

Coleus may be raised in the first place from seeds. From a large packet of seeds of a good strain many desirable plants will be obtained, though a proportion of seedlings will have to be discarded as too dull in colour. Afterwards the most desirable forms are maintained by cuttings struck in early spring. A bushy habit is induced by pinching back the leading shoots, and the vivid colouring of the leaves is developed by placing the plants near the light, ensuring that they have plenty of water. Small plants are sold in 60 size pots, but 48's is a more usual size, and, by feeding, very good plants are obtainable in this size of pot.

CHAPTER XX

CUT FLOWERS FROM THE OPEN GROUND

The principal appeal of this chapter will be to those who have succeeded in establishing themselves on a busy main road, especially one leading from a seaside resort to popular towns. Along such in normal times streams of motor-coaches and cars pass, laden with people with money to spend. The enterprising nurseryman who knows how to make a show should be able to transfer some of that money to his own pocket.

Cut flowers from the open ground are profitable only when retail prices are obtained for them, unless they are grown on a large scale. For this reason the casual trade should be encouraged by fair dealing, by offering flowers in good condition and of long-lasting kinds, so that the purchaser when she (it is usually a " she ") reflects on her purchase the day after is satisfied with it and mentally registers the place where she made it.

Though there are innumerable flowers which can be cut, the number of really good cut flowers is surprisingly small; that is, flowers which travel well and are reasonably long-lasting in water. In addition to outdoor chrysanthemums dealt with in a previous chapter, the most popular and generally suitable for the general nurseryman are: perennial scabious, larkspur, pyrethrums, cornflower, calendula, asters, nigella, bulb iris, sweet peas, gladioli, tulips and daffodils.

Scabious

The variety now widely grown is Scabiosa caucasica Clive Greaves. This is a robust plant which produces flowers in abundance of a good blue-mauve. The plant is a native of the limestone hills, and lime in the soil is essential. Prepare the soil by deep digging and ploughing, working in a dressing of good dung, in autumn. Scatter lime on the surface at the rate of 6 oz. per square yard. Work this in in February, and plant in March 1 ft. apart in rows 2 ft. apart.

A good crop of flowers will be produced the first season, but to make the bed really profitable top-dress every year in February with well-rotted dung; this will produce flowers of good size and substance. Every third year lift and divide the plants, taking the opportunity to deeply stir and lime the soil.

Larkspur

This is an annual which when well grown is very attractive. It is much the best and most useful when sown in autumn, but this can only be done on well-drained soils and in districts where winter is not too wet or cold. Damp is a very great enemy. An over-rich soil is not desirable; an ordinary light soil, not manured, will serve. A dressing of 1 cwt. of sulphate of potash per acre is useful for imparting winter hardiness.

Sow the seeds in August, and put out the seedlings in September on ground that has been dug or ploughed and then rolled fairly firm. Plant 1 ft. apart in rows 18 in. apart. Keep the crop clean during the winter and the surface loose, to hasten the passage of water through it, so preventing collar-rot. In spring a quick-acting fish manure will put substance into the plants and flowers.

Pink and mauve are the most popular colours; reds and whites are not nearly so popular.

Pyrethrums

By reason of their long-lasting qualities pyrethrums are very good cut flowers, and vast quantities are sent in the season to the great markets. The plant is a perennial, requiring a light, fertile soil. It responds to good cultivation. The single varieties are most popular, and of these Eileen May Robinson, pink, and James Kelway, crimson-scarlet, are perhaps the best for general cultivation.

The plants are put out either in early autumn or spring in rows 2 ft. apart, allowing 15 in. from plant to plant. They will occupy the site for three years, so the ground should be well prepared by deep stirring and manuring. After three or at most four years the plants should be lifted and divided. As for most of the chrysanthemum family (of which the pyrethrum is a member), lime is necessary; the plant does not thrive in acid soils.

Cornflower

The cornflower grown in nurseries for cutting is the annual species centaurea cyanus, and of this only the blue is widely grown. The flowers command the readiest sale in May and June from autumn-sown seed. The plant is fairly hardy and will withstand the winter in most localities. The seed is cheap and is often sown direct into the open ground in August in rows 18 in. apart, the plants being thinned to 1 ft. apart. Those who are familiar only with spring-sown cornflowers will be amazed at the robustness and quantity of flowers obtained from autumn sowing. On good land 18 in. is not too much to allow between the plants in the rows.

Calendula

This flower has become extremely popular, possibly because its brilliant orange colour consorts well with modern furnishings. The best varieties for general culture are Orange King Improved and Camp Fire. The pale shades are not so popular as the full orange shades.

The plant is quite hardy, and seeds should be sown in August where the plants are to flower in drills 1 ft. apart; the plants are thinned to 1 ft. apart before winter. A successional sowing may be made in March if ground is available. This will flower during summer and autumn. An ordinary fertile soil will grow calendulas well, and no fresh manure is necessary or desirable.

Asters

The plant familiarly known and grown as asters belongs to the genus callistephus. The true aster is the Michaelmas Daisy. However, it is as aster that callistephus is listed and sold to the general public, so we will use the name here. It is a summer-flowering annual, raised from seeds sown in mild heat in late March or April and planted out in May 1 ft. apart in rows 1 ft. apart. The most popular kinds are the singles of the *Sinensis* type and the market strains of the Ostrich-Plume type. These may be obtained in separate colours, but mixed bunches are acceptable to the buying public. All the colours blend well together.

To produce the best flowers on long stems a fertile soil is necessary. It should be cultivated deeply in the autumn and before planting. A good fish guano can take the place of manure if the latter is scarce, but some moisture-holding material is desirable on the lighter types of soil.

Nigella

There is a certain demand for this annual, though usually the prices obtained are not very high. It is most useful grown in the same way as cornflowers—from autumn sowing—but it is not nearly so useful as cornflowers for a market cut flower. The flowers of the most suitable varieties are a beautiful blue—always a popular colour. Nigella damascena Miss Jekyll, and N. d. Miss Jekyll, dark blue are the most widely grown. The general cultural outline is as for cornflowers.

Nigella is perhaps less hardy than cornflowers to stand the winter; on the other hand, it grows better than cornflowers from spring sowing, and where a good summer trade is done in cut flowers a breadth of March-sown nigella may prove very popular.

Bulbous Iris

We have touched upon irises in the chapter on forcing flowers. Bulbous irises are also grown extensively out of doors. Indeed, when the importation of cheap bulbs from Holland was at its height irises were grown in such quantities that the wholesale price was often unremunerative. A better price is obtained from the retail trade, and there can be no doubt the flower is popular. The Dutch group is the most useful. Wedgwood, Imperator, Yellow Queen and Van Everdinger are widely grown. A pure white variety suitable for wreath-work is White Excelsior.

A warm, sheltered position, such as one of the sunny borders under a glasshouse, is needed. The soil should be fertile, but free from fresh manure. Manure applied for a previous crop will be in the right state of decomposition for iris. Lime is necessary, and should be worked into the soil before planting. Planting is done in October.

The corms are put 2 in. deep and 2 in. apart in rows 9 in. apart. The beds should be kept clean and the surface soil loose. After the stems have been cut the corms are not worth saving, as usually much of the foliage is removed with the flower. Some growers attempt to obtain two crops, but the safer plan is to purchase fresh corms every year.

Sweet Peas

Though outdoor sweet peas may not always pay if one is dependent on wholesale prices, where retail prices can be secured the crop is very profitable. A well-drained, fertile soil is necessary, and the site should be sheltered from the north and east, but otherwise open. The heavy dressings of manure sometimes advised are both unnecessary and harmful. If manure was applied for a previous crop, a "complete" fertilizer will suffice formed by mixing equal parts of hoof and horn meal, superphosphate (16 per cent. P_2O_5) and sulphate of potash, and applying at the time of preparation at the rate of 4 oz. per square yard. Lime also is necessary, and should be applied to the surface after autumn digging.

The seeds are sown in October in size 60 pots. A few suitable varieties are: Flamingo, Welcome, George Shawyer, Powerscourt, Ambition, Gold Wings, Moneymaker, Avalanche, Pinkie, Debutante and Marion. There are many others. The plants are kept very hardy during the winter, and protection is given only from heavy rain and during very severe weather. When the seedlings are 3 in. high the tip is pinched out to encourage the development of side-shoots from the base, which produce the best flowers.

In April the plants are put out 9 in. apart in double rows 14 in. apart and 6 ft. between the double rows. The plants are grown on the cordon system—that is, all

side-shoots and tendrils are removed as fast as they appear, and one shoot, formed from one of the side-shoots produced by the first stopping, is taken up the supports.

The supports may consist of end and intermediate posts 6 ft. out of the ground, with three cross-pieces secured to each at the bottom, middle and top. Between the cross-pieces fairly strong wire is strained; either bamboo canes or stout string are fastened to the wires, one against each plant. As the plant grows the stem is secured to its support by loose ties of raffia. When the stems have reached the top of the supports they must be "dropped"—the stems are untied, then about 4 ft. is laid just above the ground surface (taking great care not to crack them) and the stems are taken up supports about 4 ft. in advance of those previously occupied.

When the plants are coming into flower a mulch of well-decayed manure is useful and obviates the need for watering, which is to be avoided if possible. If manure is unprocurable apply a fertilizer made by mixing blood-meal, nitro-chalk and superphosphate (16 per cent. P_2O_5) and put on at the rate of 1 oz. per square yard.

Tulips

In normal times and in southern districts large quantities of Darwin tulips are grown out of doors. It is necessary to be able to obtain good clean bulbs fairly cheaply for tulips to be able to compete successfully with other outdoor spring flowers.

Popular varieties of Darwins are: Bartigon, City of Haarlem, Farncombe Sanders, Princess Elizabeth, Clara Butt, Afterglow, Rev. H. Ewbank, Bouton d'Or and Mrs. Moon; the two last named are yellow "cottage" tulips.

The bulbs should be planted in October in drills 4 in. to 6 in. deep, according to the size of the bulbs, and 9 in.

apart, omitting each sixth row, to provide a path. The bulbs should be set 6 in. apart in the rows. The ground should have been deeply stirred and brought to a good tilth before planting. It should not have grown tulips for at least three years. In spring the rows are kept clear of weeds. After the flowers are cut the bulbs are dug up and scrapped. It is useless depending on them a second season.

Daffodils

The outdoor cultivation of narcissi is usually confined to those who have a grass orchard where the bulbs can be naturalized. If such is available the bulbs used for forcing may be planted out each year. They will quickly recuperate and, provided the foliage is left to die away naturally each year, will increase. Only the flowers should be cut. The presence of the foliage is essential for building up next year's bulb.

CHAPTER XXI

CLOCHE CULTIVATION FOR NURSERYMEN

CONTRIBUTED BY CAPT. J. L. H. CHASE

CONTINUOUS cloches differ from all other forms of glass protection available to nurserymen in their mobility and the fact that the crops under them need so little attention as regards watering and ventilation. They should be regarded much more as an aid to growing early and high-quality outdoor crops than for growing forced crops.

Continuous cloches are of two main types: the triangular-shaped tent type formed from two sheets of glass, and the more modern Barn type using four, two for the walls and two for the roof. This type is popular with commercial growers on account of the greater head-room at the sides of the cloche. Of the various types and sizes, that used chiefly for commercial work is about 2 ft. wide, 2 ft. long, and 15 or 16 in. high at the centre. Each cloche is a rigid structure in itself, and can easily be moved about.

Cloches are used end to end in continuous rows, and at most times of the year the ends are kept closed with sheets of glass to prevent draughts. When used commercially, cloches are usually arranged in double rows, then an 18 in. or 2 ft. path, then two more rows and so on. A space of 3 in. or 4 in. is, as a rule, left between the double rows. This means that each double row and pathway occupies 6 ft., and the effective width of a row of cloches is therefore a yard.

This makes calculation simple as to the number of

cloches required to cover a given area. A 1000-yard run of cloches will cover an area of 1000 sq. yd.

Ordinarily, the cloches are placed end to end touching each other. In hot weather, however, it is sometimes an advantage to space them out a couple of inches apart to give extra ventilation. Used during the summer months, it is also advisable, for some crops, to give a light flecking of lime-wash outside the cloches for shading. It will gradually get washed off, but will serve its purpose, and the rain will clean the cloches for the winter season.

In country areas cloches will remain reasonably clean for several years, but close to industrial towns, where the atmosphere is very dirty, it is advisable at least once a year to turn a hose on to them, and a worker can rub them over with a cloth as he walks down the line.

The price of the different types varies, but a round figure for enough cloches to cover an area of 1 acre—*i.e.*, about 4800 yd. run is £1,200 (1946), with other areas in proportion. The principal cost is the glass, so it will fluctuate with the price of that commodity.

Uses of Cloches

There are two ways in which a nurseryman can use his cloches. First of all, he can run a regular rotation, so that three, four or five crops during the season have the advantage of cloche protection. Crops will be early and of fine quality. They will therefore fetch a high price, but there is a further advantage, in that once having entered the market with a certain crop early in the season, a grower will find that he will more easily market the outdoor crop which follows it. The value of the cloches for any particular crop may therefore be greater than the return for the cloche crop itself.

The second way in which cloches may be used is as a

general reserve of protection for the nursery. A run of cloches can be of the greatest value for carrying out certain odd jobs, and may save much greenhouse space. Such jobs are seed-raising, protection of cuttings when first put out, and any special crops in time of wind or sudden cold, and the ripening-off of tomatoes, shallots, onions, and so on, as well as of flower seed crops which otherwise might not mature at all.

To get the best value out of the cloches full use must be made of their mobility. It is not suggested that they should be used on the same piece of ground throughout the year; cloches should keep moving from crop to crop. They may either be carried one in each hand, arranged on a light truck to carry between twelve and twenty cloches, or even moved on a truck carrying sixty cloches and drawn by a tractor. When planning a rotation, however, it is best to see that they do not have to move farther than necessary from one crop to the next.

The cloche season may conveniently be divided into four periods: early spring crops which occupy the cloches for the first three or three and a half months of the year, late spring crops from early April till the danger of frosts has passed, summer crops from June onwards, and autumn crops from September or early October until the end of the year.

Early Spring Crops

The choice of spring crops lies between lettuce, radishes, carrots and peas. Of these alternatives, lettuce is by far the most popular and generally the most profitable.

Lettuce

Early spring lettuce is best sown under cloches in October, or in late September in northern districts. May King is found to be the best variety in all parts of the

country, but some growers still prefer Borough Wonder and Winter Victor. Lettuce seedlings can be sown four rows to the cloche, not too thickly, and pricked out to their permanent quarters under other cloches any time from mid-December to late January. Some growers like to make a double sowing in October, one ten days after the other, the earlier one for transplanting in December and the later one for January. Plants are put out three rows to the cloche, with 8 in. between plants. Lettuce will be ready to cut early in April, or, in a particularly early year, at the end of March. The cloches may remain in position until the first lettuce are cut, and then be removed, but the lettuce will come to no harm if decloched for a week or ten days before being cut.

Radish

An alternative to lettuce is radish. Short Top forcing variety should be used, and sowings may be made from mid-October to mid-February. Earlier sowings will be ready to pull about the first week in March, and the later sowings by about the third week. During this fortnight there may be a considerable fall in prices, and the earlier sowing is therefore preferable. Some growers broadcast under the cloches, but better results are usually obtained by drilling five rows.

Carrots

Another early spring crop which can pay well is carrots. A variety like Early Nantes is usually used and sown during the second half of January, five rows to the cloche. There is no need to give protection after the beginning of April, and the carrots will be ready to pull early in May.

Peas

Peas may be sown in mid-November, or even earlier in the north, but some growers prefer to wait until

January. There is no particular point in growing the dwarf variety, though many growers like Kelvedon Wonder. The better return is probably obtained by growing a taller variety, like Laxton's Superb or Foremost. Two rows are sown to the cloche, and the cloches are kept in position over the peas until they reach the top of the glass, probably in early April. The cloches must then be removed; if the foliage is actually touching the glass it will be cut should there be a frost. There is, of course, some danger in decloching peas in early April, but the crop will have been grown hardy, and only in very severe frost will any damage be done. The once-popular practice of intercropping two rows of lettuce with peas is now falling into disfavour because in a quick-growing year the peas make too much growth, and interfere with the lettuce before it can be cut.

Late Spring Crops

We now pass to the late spring crops which follow one of the four early crops mentioned above. The cloches will be released in mid-March if the crop is radishes, and in early April if one of the three other crops has been selected.

French Beans

For mid or late March sowings to follow the radish, the most profitable crop is probably a quick-maturing variety of French beans. A double row is sown under the cloches, decloched at the end of May, and the first beans will be picked at the end of that month or in early June, and will always fetch a very good price.

Tomatoes

During the war tomatoes were the favourite late spring crop for cloche work. Plants raised in a green-

house and put out under cloches about the second week in April in the south, and at the end of the month in the north, will reach the top of the cloches by the end of May. If they are put out earlier there is a danger in a warm season that they will reach the tops of the cloches and touch the glass too soon. In this case they may be cut by a late spring frost, though plants not touching the glass will be protected from very heavy frosts. At the end of May the cloches are removed and the plants grown in the usual outdoor manner.

If the cloches are not required for a summer crop they may be stood on end to give extra protection from wind.

Some varieties which have given very good results are Harbinger, Hundredfold and Stonor's Moneymaker.

In the autumn the cloches can again be used for ripening the crop. Some time in September it is usual to destake the tomatoes and to lay them on the ground, preferably on chopped straw. The cloches are then replaced, and help to ripen off any remaining fruit. The value of the cloches in growing tomatoes is not only in increasing the crop, but in throwing the peak period three or four weeks earlier. When cloches are used, about three-quarters of the crop should have been picked by mid-September before the glut of outdoor tomatoes sets in.

Marrows

Early marrows are another late spring crop which pays well. The plants should be raised in heat, and put out in the third or fourth week of April under cloches, which may be safely removed by the end of May. The first young marrows are cut in early June, when they command a very high price.

Runner Beans

An early variety of runner beans may be sown under cloches in the third week in April, decloched at the end of May, and either grown on staked or on the flat. This crop pays particularly well, as there is at least a month of fruiting before the outside beans come in. During this period they will be sold at a very high price, and after that there will be the full fruiting season of ordinary outdoor beans.

Sweet Corn

This is a crop which is growing in popularity in this country, and an early variety like John Innes Hybrid is particularly suited to cloche cultivation. The seed should be sown two rows to the cloche in the third week in April, thinned to 9 in. apart, and decloched as soon as the corn reaches the top of the cloches about the end of May. This start is all that the sweet corn needs, and it will be found that an early variety will crop at the end of July, or even earlier in some districts. There is therefore no difficulty whatever about ripening.

Summer Crops

For summer crops the choice is somewhat limited.

Cucumbers

Cucumbers are a good proposition, and the frame cucumbers pay better than the ridge. There are now some very high-quality varieties of ridge cucumbers, but the public has had so many poor varieties foisted on it during the war that it is most unlikely there will be a good market for them now that the war is over. A frame cucumber like Conqueror gives excellent results. The plants are put out 3 ft. apart under cloches in the last

week in May and covered for six weeks, or if possible throughout the season.

Melons

Another profitable summer crop is melons. These should be put out at the same time, and involve less labour than most people think. In a very dry season hand pollination may be necessary, but in a normal year it can be safely omitted. Not more than two melons should be grown on each plant. To save labour drastic pruning should be carried out after the melons have set.

There is also a limited market for aubergines and sweet peppers, both of which are very paying propositions.

Autumn Crops

During September cloches are almost always in use for ripening-off tomatoes or onions. They are, however, free again from the beginning of October onwards, and there are one or two crops which benefit from cloche protection during the autumn months.

Endive

This is probably the best cloche crop of all. It should be sown in the open in the latter part of July, and cloched from the beginning of October onwards. This will protect the crop from excessive wet, which rots the centre of the plants. Cloches may also be used for blanching endive by giving them a thick coating of whitewash inside the cloche and also whitening the ends. The blanching operation takes about three weeks to carry out.

Lettuce

Some growers like to put in an autumn crop of lettuce sown in mid-August, and cloched from the beginning of October. This turns in in November and December, and

occasionally fetches a good price. This winter crop is, however, more subject to disease than the October sowing. In practice it is found to offer an inadequate reward to the grower, and is not therefore very much in favour. The modern tendency is to omit the autumn crop, and to sow the October spring lettuce *in situ* instead of transplanting, and covering until April.

Plant-Raising

There are a number of other crops which nurserymen favour. First there is the question of plant-raising. There is no better way of raising brassicae plants than under cloches. With the natural ventilation they grow sturdily, and make excellent plants which go right ahead when planted out in permanent quarters.

Cauliflowers are usually sown in August or September and covered from October to April. Brussels, cabbage and onion plants are sown in January directly under cloches and protected until March. Leeks are sown in February and protected until April. As a rule three rows of brassicae and four rows of onions and leeks are sown under each row of cloches.

Excellent tomato plants may also be raised sowing directly under cloches at the end of March. The usual practice is to sow 1 in. square, and about the beginning of May to prick out into cardboard pots sunk in a shallow trench and re-covered with cloches until the third week in May, when the plants are ready to go out in the open.

Marrows and cucumbers sown 3 in. square in late April or early May may be raised under cloches in the same way for outdoor work.

Cloches are widely used for covering strawberries during the spring. It is usual to protect the first-year plants, as these give the earliest crop of all and will be

ready to pick in early May, or even late April. The plants may be covered from January, and many growers prefer to treat their strawberries as annuals, planting two rows at 6 in. spacing under each row of cloches. If it is desired to crop a second year in the open, one row may be scrapped and every alternate plant taken out of the second row. The quality is better than forced fruit growing in the greenhouse, owing to the natural ventilation, and the cloches also serve to protect from birds. It is advisable in hot weather to give the cloches a light flecking of whitewash to protect from scorch.

It is not possible here to do more than touch on the question of flower-growing under cloches. The most profitable use is probably for annuals, which if sown directly under cloches in September are ready to pick at least a month before outdoor sowings. Such subjects as nigella, sweet sultan, larkspur, viscaria and scabious are particularly successful. They may be followed by asters and zinnias. These will occupy the cloches from early April onwards.

It must be emphasized that the cloches are used only to start the crops and that no attempt is made to pick from under the glass except in the case of polyanthus and certain crops like violets, which may be covered throughout the winter. This crop is usually covered from October to February, and is often followed by strawberries.

In early spring cloches may also be used for forwarding certain bulbs. Some varieties of daffodils respond particularly well, and lilies-of-the-valley are also a very good subject. There is, in fact, just as much scope for the use of cloches in flower-growing as in the forwarding of vegetables and plants.

Since the war, however, less experimental work has been done on flowers than on vegetables, and nurserymen

should make their own experiments and discover for themselves how cloches will best help them in flower-work. There is no doubt that there is a vast field as yet unexplored, and that there are many crops as yet untried which will prove extremely profitable when given cloche protection.

CHAPTER XXII

THE SHOP AND BUSINESS-GETTING METHODS

THE general plan of the nursery on which this book is broadly based makes provision for a small sales shop in which the produce of the nursery is sold. The site of the nursery will, of course, decide whether such an adjunct is justifiable. If it is on or near a main road, then it will be well worth while.

A very common arrangement where the nursery is more isolated is to have a shop in the nearest town and feed the shop by daily deliveries from the nursery. In such a case the shop must obviously be in a main shopping street and a considerable trade will have to be done if it is to pay. Such arrangements can and do pay when the closest attention to business principles is given, but it is one which the beginner should not enter into until considerable experience of public demand and seasonal requirements has been obtained. I believe that greengrocers and florists figure high in the frequency of bankruptcy!

The trade calls for a high standard of acumen and experience, and a good capital backing, otherwise losses through over- or under-stocking can be crippling. I have no wish to discourage anyone, but I am bound to say that anyone who thinks keeping a shop is easy money is a fool and is asking for all he will probably get! It is a skilled job requiring long experience and a particular " flair ".

With regard to the fitting out of the shop, one may learn

more by casually examining a few florists' shops than by reading pages of writing. The window-spaces are taken up with a representative display of the items on offer. Tomatoes, cucumbers and such like are displayed in baskets or paper-lined boxes of stained deal. Flowers are displayed in large plain earthenware vases.

Inside the shop is the small counter, with scales and shelves with more flowers or whatever is on offer. Wreaths are suspended on wires reaching down from the roof. Most of these are made to order only, except in the larger florists' shops. But one or two may be kept ready made up for advertisement, as well as for immediate sale.

No instructions for making wreaths or bouquets have been given in this book, simply because it is a trade that can only be learned by experience. If wreaths are not made in the nursery where the reader serves his apprenticeship, then lessons should be taken from a practised exponent of the art. The professional touch *must* be acquired, for even the poorest of the poor are very critical over both the flowers and the style of arrangement. Indeed, it is a well known, if peculiar, sidelight on human psychology that far more money is spent on wreaths by the poor than by the rich.

In addition to the actual products of the nursery a quite legitimate and profitable trade may be built up in seeds, fertilizers, insecticides and various sundries. There are several highly reputable firms who will be only too glad to appoint the nurseryman as agent for their goods. They will supply seeds ready packeted in varieties which find favour with the amateur. The packets are attractively printed, and generally speaking the seeds are of good quality. The discount is usually in the region of $33\frac{1}{3}$ per cent., and unsold seeds are usually returnable—a very good arrangement from the retailer's viewpoint. The

firms who supply these seeds are able to forecast, with some accuracy, public tastes and demands, and the budding retailer cannot do better than be guided by them as to the kinds and varieties to stock. Three of the largest firms who cater for this trade are Messrs Carter, Messrs. Watkins & Simpson and Messrs. Hurst, all of London.

The haphazard and unskilful cultural methods adopted by many amateur gardeners make them a most lucrative market for the sale of insecticides and fertilizers. Here again there are firms who cater specially for the demand and supply insecticides and fertilizers neatly and attractively packeted. Two of the largest firms in this trade are Messrs. Plant Protection, Ltd., of Yalding, Kent, and Messrs. George Monro of Waltham Cross.

Of sundries, raffia and tying materials generally are in demand in summer; a limited range of tools may be stocked, such as hedge-shears, hand-forks, spades and garden forks, trowels and so on. Care must be exercised in buying these; the public is curiously conservative where it buys its wares, and whilst a good trade in some items may be done, others may move disappointingly slow. For all kinds of garden tools Messrs. Brades and Messrs. Spear & Jackson, both of Sheffield, are two reliable firms. There are, of course, others.

Trade-Getting and Keeping

It is very easy to get trade. An advertising campaign will sell almost anything for a time, but the trade thus secured has got to be kept if the business is to flourish. The expenses of advertising may absorb a high proportion of the profits obtained from the goods sold as a direct result of the advertisements. The advertiser must then look to the repeat orders to obtain his return.

The extent of these repeat orders will depend on

whether the customer was satisfied, and completely satisfied at that. Advertising to sell a low-quality product does not pay in the long run. It is only the first-class product that can repay the expense when the competitive markets are being exploited. " A satisfied customer is the best advertisement " is a platitude, but also a profound and constant truth.

If the nursery is on a main road it will of itself be an advertisement. A board should be erected, setting forth the proprietor's name and a list of the main items offered. It may be made to include a space for special offers, painted dead black, and the details of the special offers inserted as necessary with white chalk. This may be supplemented with occasional advertisements in the local Press if a local trade is being sought. Casual advertising, except of special offers at particular seasons, usually fails to produce results in proportion to the outlay: the general experience of advertisers is that advertising must be consistent to yield results.

For very many nurserymen advertising never extends beyond the local Press. It is mainly the firms who specialize in mail order business whose campaigns extend to the National Press and periodicals. It has been outside our scope in this book to consider mail-order businesses, but, though the competition is keen, it is an expanding market. There is a class of buyer who thinks a thing is better if it comes from a distance away. I knew a man in Essex who regularly sent to Scotland for his flower-seeds even though the seeds had actually been grown in fields within five miles of his house and exactly the same seeds could be bought at the shop in his village. He thought that seeds coming from such a distance were sure to be better, and neither advice nor experience ever caused him to change his opinion. This mentality is very wide-

spread, and the many flourishing mail-order businesses depend on its exploitation.

The neat and effective packing of produce is a continual advertisement. The seeds, insecticides and fertilizers received from the firms mentioned above will be object lessons in this. The paper bags, punnets and so on supplied to the customer should all be attractively printed with the seller's name and an appropriate and original design. Any good printing firm will advise on these points. Something can possibly be done in the way of distributing handbills. If bedding plants or vegetable plants are raised on an intensive scale a price list containing details of kinds and varieties on offer may be distributed amongst customers, and such will be of real value.

CHAPTER XXIII

FINANCE

THE amount of capital needed to establish a nursery of the type we have considered in this book will vary with the district. Land near London is naturally more costly than land near Durham or Barrow-in-Furness, but this is balanced by the fact that London is a far better market for produce than either of the two other places mentioned. Again, land on a main road is worth more than land with no road frontage, and for agricultural purposes fertility of the soil affects values. So it will be seen that the price of land varies widely from place to place. On the other hand, prices of buildings such as glasshouses do not vary to any great extent. The tendency of the big firms of horticultural builders is to strike an average with regard to transport costs, and a London firm might quote much the same price for erecting a glasshouse in Norfolk as in the Lea Valley.

I have sought several opinions on the amount of capital needed to start a nursery. They vary as to amount, as one would expect, but the general concensus appears to be that £2,000 is a suitable and safe figure. This allows for buying one acre of land on a road near a populous and thriving town; erecting one glasshouse 140 ft. long by 30 ft. wide and installing heating apparatus of a capacity suitable for early tomatoes and spring flowers; erecting a Dutch house for maincrop tomatoes and chrysanthemums and a battery of Dutch frames for general purposes. This leaves a margin for sundries and working capital.

In certain circumstances a proportion of this £2,000 may be borrowed from a bank, a building society or from the Agricultural Mortgage Corporation. The rate of interest charged by banks varies with the "quality" of the assets and the credit-worthiness of the borrower. Government securities, shares in public utility companies and life-assurance policies, which have a cash surrender value, are all first-class securities, and money may be borrowed on them almost up to their full value at the prevailing moderate rate of interest.

Property varies somewhat with its type as to the class of security in which it falls. Some property is regarded as "first class", other types as "second class". But generally speaking property has to have some especial merit to qualify for an advance of more than two-thirds of its value. The same applies to stocks and shares when these are offered as security. Debentures in good companies may rank as first-class security, whilst Ordinary shares in a less well known company or a company engaged in a hazardous business may not be regarded as equal to second-class security. Here again the security is examined and valued on its merits. The reason underlying the different values of securities is that the rate of default is naturally highest during times of slump and trade depression, so that the banks have to realize the assets of defaulters at times when prices are at their lowest.

Other factors besides the security offered are considered. Where the bank is satisfied that the borrower is a man of integrity, character, business acumen and experience, and that the project for which the money is wanted is sound in business and stands a reasonable chance of success, it may lend money in excess of the prospective realizable value of the security offered. A higher rate of

interest on money so obtained may have to be paid, but every case is considered on its merits.

Building Societies lend money mainly on the security of house property, though the value of any land attached to the house is taken into account. The booklets issued by the various societies will give full details, the tables of repayments, and so on.

Similarly full details concerning advances by the Agricultural Mortgage Corporation, Ltd., can be obtained from the head office of the Corporation, Stone House, Bishopsgate, London, E.C. 2.

From the above it will be seen that money can be obtained on suitable securities and for suitable propositions. The reader is strongly urged to borrow money only on the terms set out above, and to avoid propositions which appear on the surface to be more attractive which emanate from unrecognized sources. If a Bank or the Agricultural Mortgage Corporation refuses to loan money, then the proposition must be regarded as unsound in business and it is in the would-be borrower's own interests that the loan should be refused. I am informed from an authoritative source that the genuine borrower with a reasonable business proposition to put forward is likely to find one of the big Banks very ready to discuss the project with him.

One or two friends who read this book in manuscript suggested that I should give some indication of the profit which one may reasonably expect from an acre of land intensively cultivated. So long as it is clearly understood that any figure given can only be very approximate and liable to be affected by many factors, I suggest that one may safely budget for an annual profit of £400 gross, or 20 per cent. on capital invested, with the nurseryman himself working on the nursery and personally supervising it.

CHAPTER XXIV

FINAL CONSIDERATIONS

In this chapter I want to consider one or two matters which could not be assigned to a definite place in any other part of the book.

First, the would-be nurseryman must remember that he will operate in a market where, in normal times, competition is very acute. In the years between the wars, when nurseries as we now know them were developing, prices at times fell to ruinous levels. Indeed, in 1928 the industry was quite literally threatened with bankruptcy. This was due to a variety of causes which must be avoided if the same is not to occur again. The chief of these causes were: (1) a complete lack of unity and co-operation between growers, (2) haphazard marketing, (3) influx of foreign produce, and (4) uneconomical and out-of-date methods.

These great evils were in part remedied by legislation between 1928 and 1932. The Acts passed in these years as they relate to horticulture are worth studying: there are still a great number of nurserymen who are unaware of them or the provisions they made for the betterment of the industry.

Amongst the legislation passed was the Act which introduced the National Mark Scheme; the Act for providing agricultural credits through the Agricultural Mortgage Corporation; the Act de-rating agricultural property of certain classes; the Act providing additional funds for research into agricultural and horticultural problems; the Act controlling imports of certain horti-

cultural produce; the Act setting up Marketing Boards which ensured a stable price to the grower; and other beneficent Acts.

The National Mark Act removed what had for long been a real grievance, in that the good grower who graded and packed his produce to a high standard stood to have his returns reduced by produce badly grown and dishonestly packed. It is likely that when normal times return this scheme will be extended so that only produce grown and packed to National Mark standards will be saleable. The beginner should bear this in mind, for only the best conforms to the requirements of the scheme.

Though considerable headway towards unity had been made before the war brought all such developments to a standstill, the nursery trade was still ill-organized. There are signs that this is coming to an end. A section of the National Farmers' Union has been formed to embrace the nursery trade, and the latter will have the benefits of the powerful voice of that great Union. It behoves all young nurserymen to give this movement full and active support. The public will never stand for exploitation of food prices, but between exploitation and a fair return to the nurseryman there is a great gulf. A fair price for an honest article should be, and is, obtainable, and no one should ask for more. But there will be no profitable sale for the low-grade produce which used to flood the markets. Indeed, it should be—and no doubt will be—the policy of the organized nursery trade to operate against such producers, and at least to see that their produce goes only for manufacturing and does not compete with the good produce.

Concomitant with membership of the Horticultural Section of the N.F.U., the young nurseryman should keep abreast of the times by following the progress of the Re-

search Station. The chief of these from the present reader's viewpoint are the Cheshunt Research Station, the John Innes Horticultural Institution, the Long Ashton Research Station (University of Bristol), the Research Stations attached to the Horticultural Departments of Reading, Cambridge and Leeds Universities, the West of Scotland Horticultural Station, the Royal Horticultural Society's Garden at Wisley, where much useful work is normally done on flowers, and the Research Station at Kirton in Lincs., where research on crops such as bulbs, etc., peculiar to Lincolnshire is carried out. Most of these publish Annual Reports; these should be studied, for such are not only useful in a practical way, but help to enlarge the mind. Their perusal should not affect one's own critical spirit, neither is one bound to accept all their teachings as gospel. Some of us are not in entire agreement with the lines research is tending to follow, but that does not affect the fact that the Research Stations are, by and large, doing a difficult job of vital importance.

There is now a National Advisory Service, whose purpose it is to give advice on agricultural and horticultural problems to both the professional and amateur gardener. As I have suggested in various parts of the book, the services of the advisers should be enlisted by the beginner on every occasion that he has to make a decision which requires experience and intimate knowledge of the industry.

My last word to my readers is, if you do start on your own, to unite with your fellow-nurserymen. We are entering an era of organized industry and organized labour. If the nursery industry is to survive it, too, must organize. The plaint of the individual, no matter how just and urgent, stands little chance of a hearing. Only the combined voice of the whole trade, combined in solid unity, will obtain for it a fair deal.

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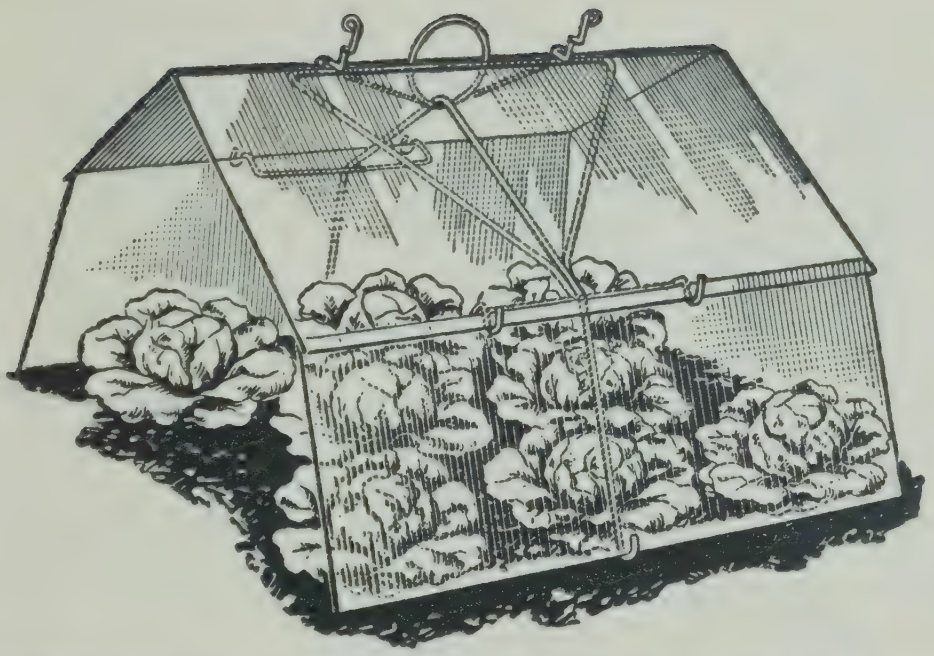

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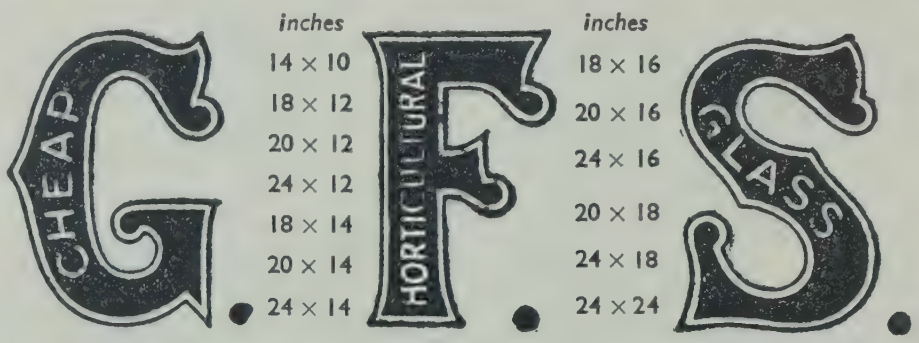

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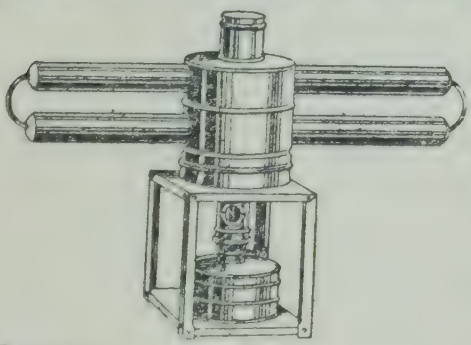

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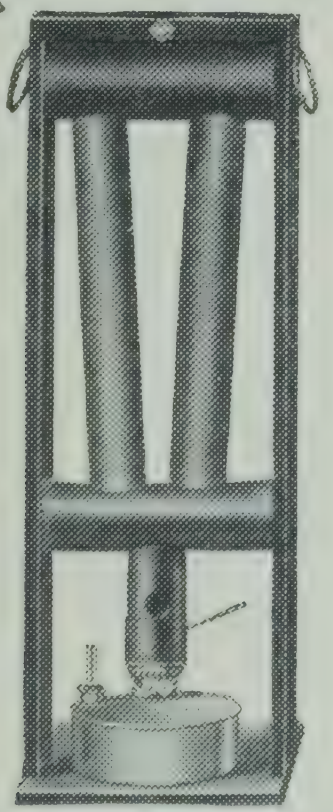

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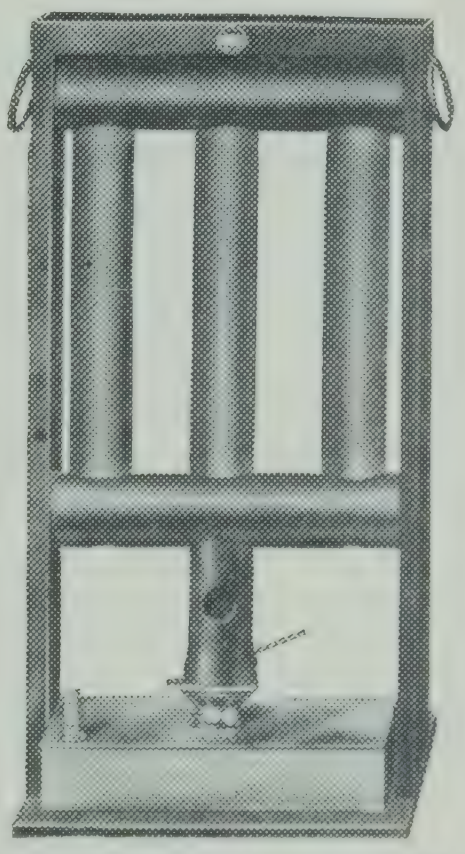

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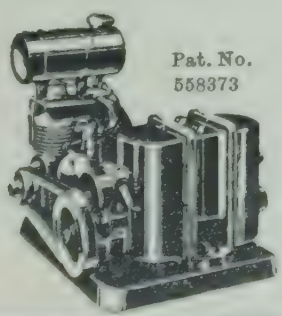

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